Lower Kaskaskia River Watershed (II) Total Maximum Daily Load

DRAFT Stage 1 Report

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Acronyms and Abbreviations

AFO	animal feeding operation
AWQMN	Ambient Water Quality Monitoring Network
BOD	biochemical oxygen demand
CAFO	confined animal feeding operation
COD	chemical oxygen demand
CWA	Clean Water Act
IBI	index of biotic integrity
Illinois DNR	Illinois Department of Natural Resources
Illinois EPA	Illinois Environmental Protection Agency
IPCB	Illinois Pollution Control Board
MBI	macroinvertebrate biotic index
MCL	maximum contaminant level
MGD	millions of gallons per day
MS4	municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
NWIS	National Water Information System
SOD	sediment oxygen demand
STP	sewage treatment plant
TMDL	total maximum daily load
TSS	total suspended solids
U.S. EPA	United States Environmental Protection Agency
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WQS	water quality standards
WTP	water treatment plant
WWTP	wastewater treatment plant

1. Introduction

The Clean Water Act and U.S. Environmental Protection Agency (U.S. EPA) regulations require that Total Maximum Daily Loads (TMDLs) be developed for waters that do not support their designated uses. In simple terms, a TMDL is a plan to attain and maintain water quality standards in waters that are not currently meeting standards. This TMDL study addresses the 1,608 square mile Lower Kaskaskia River watershed located in southwestern Illinois (Figure 1). The Shoal Creek watershed and Crooked Creek watershed drain to the Lower Kaskaskia River watershed, but are being addressed in separate TMDL studies. Several waters in the Lower Kaskaskia River watershed have been placed on the State of Illinois 303(d) list, and require the development of a TMDL. Two previous TMDL studies have been completed in the Lower Kaskaskia River major watershed: the Lower Kaskaskia River watershed TMDL (IEPA 2012) and the Highland Silver Lake watershed TMDL (IEPA 2006). Relevant information from each study is included herein where applicable.

The TMDL process establishes the allowable loading of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and instream conditions. This allowable loading represents the maximum quantity of the pollutant that the waterbody can receive without exceeding water quality standards. The TMDL also includes a margin of safety, which reflects uncertainty as well as the effects of seasonal variation. By following the TMDL process, states can establish water quality-based controls to reduce pollution from both point and nonpoint sources, and restore and maintain the quality of their water resources (U.S. EPA 1991). The Illinois EPA will be working with stakeholders to implement the necessary controls to improve water quality in the impaired waterbodies and meet water quality standards. The controls for nonpoint sources (e.g., agriculture) will be strictly voluntary.

1.1 Water Quality Impairments

This project addresses several waters on the State of Illinois §303(d) list including four impaired segments along the mainstem of the Kaskaskia River and impairments on Doza Creek, Sugar Fork, East Fork Silver Creek, and Highland Silver Lake (Table 1 and Figure 1). There are other impaired waters in the Lower Kaskaskia River watershed that are not being addressed by the TMDL study, including dissolved oxygen impairments in Prairie du Long Creek (OCB-99) and Little Mud Creek (OEA), dissolved oxygen and iron impairments in Silver Creek (OD-06), and dissolved oxygen and endrin impairments in Sugar Creek (OH-05). Of the waters being addressed by this TMDL study, four waterbody-pollutant combinations were found to be unimpaired (see italics in Table 1 and Appendix A—Unimpaired Stream Data Analysis).

In addition, several pollutants including sedimentation/siltation, sludge, temperature, total phosphorus, and total suspended solids are not being addressed as part of this project. These parameters do not have numeric water quality standards, and therefore TMDLs are not developed.

Table 1. Lower Kaskaskia River watershed impairments and pollutants (2016 Illinois 303(d) Draft List)

Name	Segment ID	Segment Length (Miles)	Watershed Area (Sq. Miles)	Designated Uses	Cause of Impairment
Kaskaskia River	IL_O-03	15.18	5,219 [a]	Aquatic Life	**Dissolved Oxygen**, Sedimentation/Siltation [b]
Kaskaskia River	IL_O-20	25.25	4,549 [a]	Aquatic Life	Phosphorus (Total) [b], Total Suspended Solids (TSS) [b], Temperature [b]
				Public and Food Processing Water Supply	**Iron**
Kaskaskia River	IL_O-30	13.3	5,811 [a]	Aquatic Life	**Iron**, Phosphorus (Total) [b], Sedimentation/Siltation [b] Total Suspended Solids (TSS) [b], Temperature [b]
				Public and Food Processing Water Supply	*Iron*
Kaskaskia River	IL_O-97	8.91	5,538 [a]	Aquatic Life	*Dissolved Oxygen*, Sedimentation/Siltation [b]
East Fork Silver Creek	IL_ODL-02	14.97	98	Aquatic Life	**Dissolved Oxygen**
Sugar Fork	IL_ODLA-01	18.56	31	Aquatic Life	**Dissolved Oxygen,** Manganese [c]
Doza Creek	IL_OZD	20.07	44	Aquatic Life	**Dissolved Oxygen,** Manganese [c]**,** Phosphorus (Total) [b], Sedimentation/Siltation [b], Sludge [b]
Highland Silver Lake	IL_ROZA	600 ac (surface area)	48	Aquatic Life	pH [d]

Italics – Based on evaluation of the last ten years of available data (2007–2016), it was determined that these segment(s) are not impaired (see Appendix A—Unimpaired Stream Data Analysis). No TMDLs are provided for these causes of impairment.
a. Watershed area includes Upper Kaskaskia River watershed (1,568 sq. miles), Middle Kaskaskia River watershed (946 sq. miles), East Fork Kaskaskia River watershed (207 sq. miles), Crooked Creek watershed (563 sq. miles), and Shoal Creek watershed (917 sq. miles).
b. These causes of impairment are not being addressed as part of this project.
c. Additional data are needed to verify impairment.
d. Impairment was removed from the 2018 draft 303(d) list and is not addressed further in this report.
BOLD – TMDLs are addressed in this Stage 1 report

1.2 TMDL Endpoints

This section presents information on the water quality standards (WQS) that are used for TMDL endpoints. WQS are designed to protect beneficial uses. The authority to designate beneficial uses and adopt WQS is granted through Title 35 of the Illinois Administrative Code. Designated uses to be protected in surface waters of the state are defined under Section 303, and WQS are designated under Section 302 (Water Quality Standards). Designated uses and WQS are discussed below.

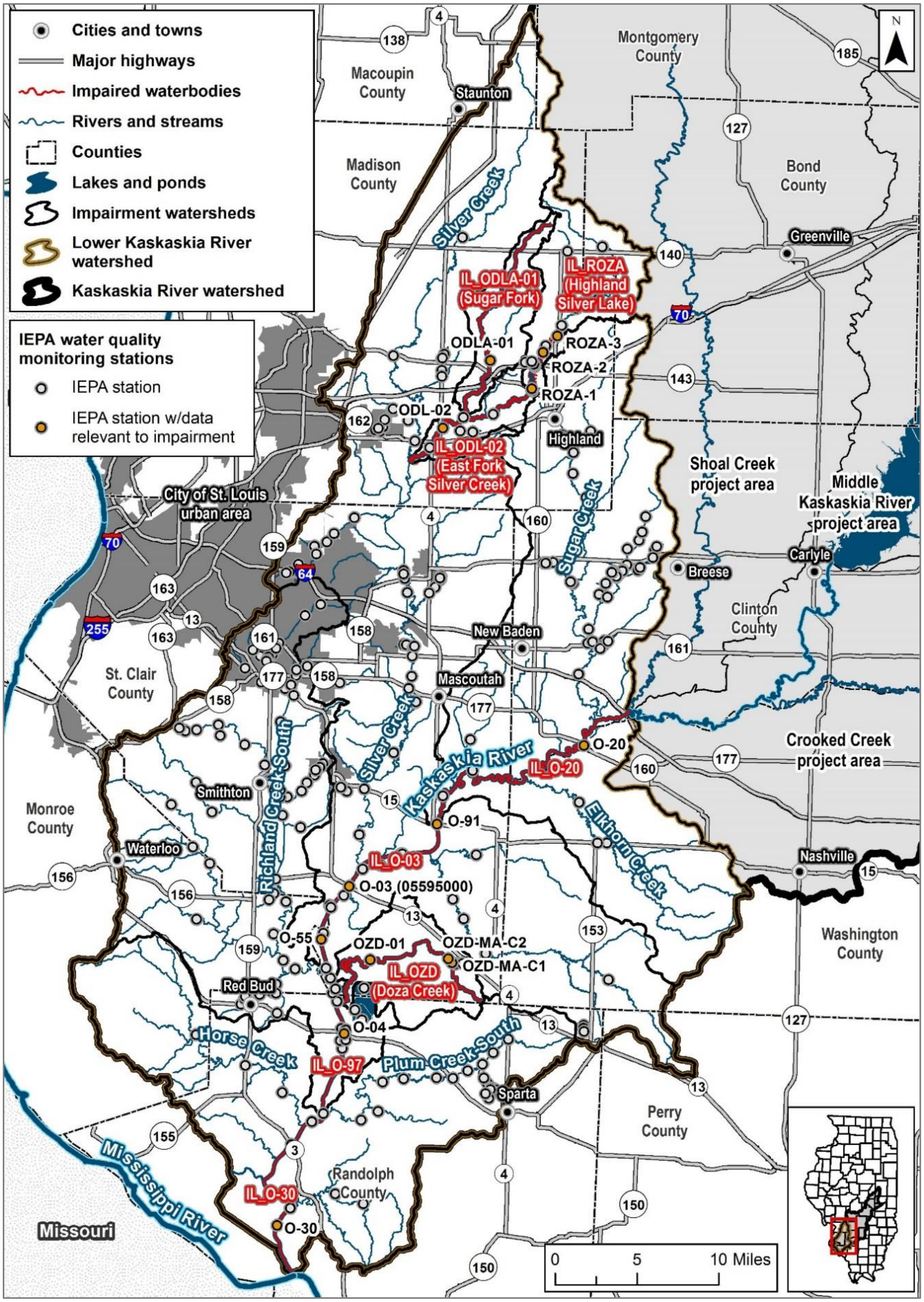

Figure 1. Lower Kaskaskia River watershed, TMDL project area.
Monitoring stations on impaired waterbodies with water quality data used in impairment assessment are labeled.

1.2.1 Designated Uses

Illinois EPA uses rules and regulations adopted by the Illinois Pollution Control Board (IPCB) to assess the designated use support for Illinois waterbodies. The following are the use support designations provided by the IPCB that apply to waterbodies in the Lower Kaskaskia River watershed:

General Use Standards—These standards protect for aquatic life, wildlife, agricultural uses, primary contact (where physical configuration of the waterbody permits it, any recreational or other water use in which there is prolonged and intimate contact with the water involving considerable risk of ingesting water in quantities sufficient to pose a significant health hazard, such as swimming and water skiing), secondary contact (any recreational or other water use in which contact with the water is either incidental or accidental and in which the probability of ingesting appreciable quantities of water is minimal, such as fishing, commercial and recreational boating, and any limited contact incident to shoreline activity), and most industrial uses. These standards are also designed to ensure the aesthetic quality of the state's aquatic environment.

Public and food processing water supply standards—These standards are cumulative with the general use standards and apply to waters of the state at any point at which water is withdrawn for treatment and distribution as a potable supply to the public or for food processing.

1.2.2 Water Quality Standards and TMDL Endpoints

Environmental regulations for the State of Illinois are contained in the Illinois Administrative Code, Title 35. Specifically, Title 35, Part(s) 302 and 611 contain water quality standards promulgated by the IPCB for general use and public and food processing water supply, respectively. This section presents the standards applicable to impairments in the study area. Water quality standards and TMDL endpoints to be used for TMDL development are listed in Table 2.

Table 2. Summary of water quality standards for the Lower Kaskaskia River watershed

Parameter	Units	Water Quality Standard
General Use		
Dissolved Oxygen [a]	mg/L	March–July > 5.0 min. and > 6.0 7-day mean Aug–Feb > 3.5 min, > 4.0 7-day mean, and > 5.5 30-day mean
Iron (dissolved)	mg/L	1.0 mg/L
Manganese (dissolved)	µg/L	Acute standard: $e^{A+Bln(H)} \times 0.9812$, where A=4.9187 and B=0.7467; H=hardness Chronic standard: $e^{A+Bln(H)} \times 0.9812$, where A=4.0635 and B=0.7467; H=hardness
Public and Food Processing Water Supply		
Iron (dissolved)	mg/L	0.3 mg/L (Public and Food Processing Water Supply Standard), 1.0 mg/L Maximum Contaminant Level (MCL) for waters supplies serving ≥ 1,000 people or ≥ 300 connections

a. Applies to the dissolved oxygen concentration in the main body of all streams, in the water above the thermocline of thermally stratified lakes and reservoirs, and in the entire water column of unstratified lakes and reservoirs.

General Use Standards

Aquatic life use assessments in streams are typically based on the interpretation of biological information, physicochemical water data, and physical-habitat information from the Intensive Basin Survey, Ambient Water Quality Monitoring Network, or Facility-Related Stream Survey programs. The primary biological measures used are the fish Index of Biotic Integrity (fIBI; Karr et al. 1986; Smogor 2000, 2005), the macroinvertebrate Index of Biotic Integrity (mIBI; Tetra Tech 2004), and the Macroinvertebrate Biotic

Index (MBI; IEPA 1994). Physical habitat information used in assessments includes quantitative or qualitative measures of stream bottom composition and qualitative descriptors of channel and riparian conditions. Physicochemical water data used include measures of conventional parameters (e.g., dissolved oxygen, pH, and temperature), priority pollutants, non-priority pollutants, and other pollutants (U.S. EPA 2002 and www.epa.gov/waterscience/criteria/wqcriteria.html). In a minority of streams for which biological information is unavailable, aquatic life use assessments are based primarily on physicochemical water data.

When a stream segment is determined to be not supporting aquatic life use, generally one exceedance of an applicable Illinois water quality standard (related to the protection of aquatic life) results in identifying the parameter as a potential cause of impairment. Additional guidelines used to determine potential causes of impairment include site-specific standards (35 Ill. Adm. Code 303, Subpart C) or adjusted standards (published in the IPCB's Environmental Register at http://www.ipcb.state.il.us/ecll/environmentalregister.asp).

Public and Food Processing Water Supply Use Standards

Attainment of public and food processing water supply use is assessed only in waters in which the use is currently occurring, as evidenced by the presence of an active public-water supply intake. The assessment of public and food processing water supply use is based on conditions in both untreated and treated water. By incorporating data through programs related to both the federal Clean Water Act and the federal Safe Drinking Water Act, Illinois EPA believes that these guidelines provide a comprehensive assessment of public and food processing water supply use. Assessments of public and food processing water supply use recognize that characteristics and concentrations of substances in Illinois surface waters can vary and that a single assessment guideline may not protect sufficiently in all situations. Using multiple assessment guidelines helps improve the reliability of these assessments. When applying these assessment guidelines, Illinois EPA also considers the water-quality substance, the level of treatment available for that substance, and the monitoring frequency of that substance in the untreated water. Table 3 includes the assessment guidelines for waters with public and food processing water supply designated uses.

Table 3. Guidelines for assessing public water supply in waters of the State (IEPA 2016)

Degree of Use Support	Guidelines
Fully Supporting (Good)	For each substance in untreated water[a], for the most recent three years of readily available data or equivalent dataset, a) < 10% of observations exceed an applicable Public and Food Processing Water Supply Standard[b]; and b) for which the concentration is not readily reducible by conventional treatment, i) no observation exceeds by at least fourfold the treated-water Maximum Contaminant Level threshold concentration[c] for that substance; and ii) no quarterly average concentration exceeds the treated-water Maximum Contaminant Level threshold concentration[c] for that substance; and iii) no running annual average concentration exceeds the treated-water Maximum Contaminant Level threshold concentration[d] for that substance; and[d] For each substance in treated water, no violation of an applicable Maximum Contaminant Level[c] occurs during the most recent three years of readily available data.
Not Supporting (Fair)	For any single substance in untreated water[a], for the most recent three years of readily available data or equivalent dataset, a) > 10% of observations exceed a Public and Food Processing Water Supply Standard[b]; or b) for which the concentration is not readily reducible by conventional treatment, i) at least one observation exceeds by at least fourfold the treated-water Maximum Contaminant Level threshold concentration[c] for that substance; or ii) the quarterly average concentration exceeds the treated-water Maximum Contaminant Level threshold concentration[c] for that substance; or iii) the running annual average concentration exceeds the treated-water Maximum Contaminant Level threshold concentration[c] for that substance. or, For any single substance in treated water, at least one violation of an applicable Maximum Contaminant Level[3] occurs during the most recent three years of readily available data.
Not Supporting (Poor)	Closure to use as a drinking-water resource (cannot be treated to allow for use).

a. Includes only the untreated-water results that were available in the primary computer database at the time data were compiled for these assessments
b. 35 I11. Adm. Code 302.304, 302.306 (http://www.ipcb.state.il.us/SLR/IPCBandIEPAEnvironmentalRegulations-Title35.aspx)
c. 35 I11. Adm. Code 611.300, 611.301, 611.310, 611.311, 611.325.
d. Some waters were assessed as Fully Supporting based on treated-water data only.

One of the assessment guidelines for untreated water relies on a frequency-of-exceedance threshold (10 percent) because this threshold represents the true risk of impairment better than does a single exceedance of a water quality criterion. Assessment guidelines also recognize situations in which water treatment that consists only of "...coagulation, sedimentation, filtration, storage and chlorination, or other equivalent treatment processes" (35 Ill. Adm. Code 302.303; hereafter called "conventional treatment") may be insufficient for reducing potentially harmful levels of some substances. To determine if a Maximum Contaminant Level (MCL) violation in treated water would likely occur if treatment additional to conventional treatment were not applied (see 35 Ill. Adm. Code 302.305), the concentration of the potentially harmful substance in untreated water is examined and compared to the MCL threshold concentration. If the concentration in untreated water exceeds an MCL-related threshold concentration, then an MCL violation could reasonably be expected in the absence of additional treatment.

Compliance with an MCL for treated water is based on a running 4-quarter (i.e., annual) average, calculated quarterly, of samples collected at least once per quarter (Jan.–Mar., Apr.–Jun., Jul.–Sep., and

Oct.–Dec.). However, for some untreated water intake locations, sampling occurs less frequently than once per quarter; therefore, statistics comparable to quarterly averages or running 4-quarter averages cannot be determined for untreated water. Rather, for substances not known to vary regularly in concentration in Illinois surface waters (untreated) throughout the year, a simple arithmetic average concentration of all available results is used to compare to the MCL threshold. For substances known to vary regularly in concentration in surface waters during a typical year (e.g., nitrate), average concentrations within the relevant sub-annual (e.g., quarterly) periods are used.

2. Watershed Characterization

The Lower Kaskaskia River watershed is located in southwestern Illinois (Figure 1). The watershed begins at the confluence of the Kaskaskia River and Shoal Creek and ends where the Kaskaskia River joins the Mississippi River south of St. Louis, Missouri. A TMDL was previously developed for the Lower Kaskaskia River watershed (IEPA 2012), and much of the information presented in that report is applicable to the current TMDL project. There have been no known changes in the project area; therefore, the existing Lower Kaskaskia River watershed TMDL provides much of the basis for the watershed characterization and source assessment below.

2.1 Jurisdictions and Population

Relevant information on jurisdictions and population can be found in the Lower Kaskaskia River Watershed Total Maximum Daily Load report (IEPA 2012). The project area is located in Bond, Clinton, Macoupin, Madison, Monroe, Montgomery, Perry, Randolph, St. Clair, and Washington counties. The city of St. Louis urban area intersects the western boundary of the watershed.

2.2 Climate

In general, the climate of the region is continental with hot, humid summers and cold winters. Relevant information on climate can be found in the Lower Kaskaskia River Watershed Total Maximum Daily Load report (IEPA 2012).

2.3 Land Use and Land Cover

Relevant information on land use and land cover can be found in the Lower Kaskaskia River Watershed Total Maximum Daily Load report (IEPA 2012). Cultivated crops make up the majority of the land cover in the Lower Kaskaskia River watershed. There are several small cities in the watershed, with the majority of development located in the city of St. Louis urban area.

2.4 Topography

Relevant information on topography can be found in the Lower Kaskaskia River Watershed Total Maximum Daily Load report (IEPA 2012).

2.5 Soils

Relevant information on soils can be found in the Lower Kaskaskia River Watershed Total Maximum Daily Load report (IEPA 2012). Soils are primarily a mixture of silt loam or loam with moderate infiltration rates when thoroughly wetted and sandy clay loams with low infiltration rates when thoroughly wetted.

2.6 Hydrology

Relevant information on hydrologic conditions can be found in the Lower Kaskaskia River Watershed Total Maximum Daily Load report (IEPA 2012). Active U.S. Geological Survey (USGS) flow gage sites in the watershed are located along Kaskaskia River impaired segments O-20 (05594100), O-03 (05595000), and O-97 (05595240), and along Silver Creek (055944500 and 05594800) and Richland Creek (05595200).

2.7 Watershed Studies and Information

This section describes several of the studies that have been completed in the watershed:

- **Bank Erosion Study of the Kaskaskia River, Carlyle Lake to New Athens, Illinois** (USACE 2000)

  Study completed by U.S. Army Corps of Engineers (USACE) in partnership with the Original Kaskaskia Area Wilderness, Inc. and Illinois Department of Natural Resources (Illinois DNR) to determine sources of lateral erosion on the Kaskaskia River and to propose remedial actions that can be taken to mitigate erosional processes. Headcutting was identified as a major source of erosion due to the navigation project completed on the Lower Kaskaskia River. Several measures for remediating erosion are proposed, including grade control structures to address headcutting.

- **Kaskaskia River Watershed, An Ecosystem Approach to Issues and Opportunities** (Southwestern Illinois RC&D, Inc. 2002)

  The plan encompasses the larger Kaskaskia River watershed from Champaign County to Randolph County in southwestern Illinois, covering over 10 percent of the state of Illinois. The purpose of the plan was to begin a coordinated restoration process in the Kaskaskia River watershed based on sound ecosystem principles. The plan made recommendations on sustainability, diversity, health, variety, connectivity, and the ecosystem's ability to thrive and reproduce in order to promote the sustainability of the ecosystem and strengthen the economic base and the quality of life of residents in the region.

- **Aerial Assessment Report on Highland Silver Lake and East Fork of Silver Creek** (Limno Tech 2005)

  Report completed to investigate sources of lakeshore and streambank erosion contributing to manganese, total phosphorus, and dissolved oxygen impairments in Highland Silver Lake. Lakeshore and stream channel conditions were investigated upstream, within, and downstream of Highland Silver Lake. Research methods included aerial video mapping, use of topographic maps, and field verification of findings.

- **Highland Silver Lake Watershed Total Maximum Daily Load Report** (IEPA 2006)

  The completed Highland Silver Lake TMDL Report contains TMDL allocations for Highland Silver Lake. Causes of impairments include aldrin, chlordane, dissolved oxygen, manganese, and total phosphorus. Highland Silver Lake is located directly upstream of East Fork Silver Creek (ODL-02), which is addressed in this report.

- **Lower Kaskaskia River Watershed Total Maximum Daily Load Report** (IEPA 2012)

> The completed Lower Kaskaskia River TMDL Report contains relevant information and data for this TMDL. Causes of impairments included atrazine, dissolved oxygen, fecal coliform, manganese, pH, and total phosphorus.

3. Watershed Source Assessment

Source assessments are an important component of water quality management plans and TMDL development. This section provides a summary of potential sources that contribute listed pollutants to the Lower Kaskaskia River watershed.

3.1 Pollutants of Concern

Pollutants of concern evaluated in this source assessment include iron and parameters influencing dissolved oxygen. Dissolved oxygen in streams can be affected by biochemical oxygen demand, phosphorus, ammonia, and sediment oxygen demand in addition to non-pollutant causes such as lack of reaeration. These pollutants can originate from an array of sources including point and nonpoint sources. Eutrophication (high levels of algae) is also often linked directly to low dissolved oxygen conditions, and therefore nutrients are also a pollutant of concern. Point sources typically discharge at a specific location from pipes, outfalls, and conveyance channels. Nonpoint sources are diffuse sources that have multiple routes of entry into surface waters, particularly overland runoff. This section provides a summary of potential point and nonpoint sources that contribute to the impaired waterbodies.

3.2 Point Sources

Point source pollution is defined by the Federal Clean Water Act (CWA) §502(14) as:

> any discernible, confined and discrete conveyance, including any ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation (CAFO), or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agriculture storm water discharges and return flow from irrigated agriculture.

Under the CWA, all point sources are regulated under the National Pollutant Discharge Elimination System (NPDES) program. A municipality, industry, or operation must apply for an NPDES permit if an activity at that facility discharges wastewater to surface water. Point sources can include facilities such as municipal wastewater treatment plants (WWTPs), industrial facilities, CAFOs, or regulated stormwater including municipal separate storm sewer systems (MS4s).

3.2.1 NPDES Facilities (Non-CAFO or stormwater)

NPDES facilities in the study area include municipal and industrial wastewater treatment. Nutrients and oxygen-demanding substances can be found in these discharges and may contribute to low dissolved oxygen impairments. There are also public water supply facilities in the watershed, and associated iron filter backwash may contribute to iron impairments.

There are 65 individual NPDES permitted facilities in the Lower Kaskaskia River watershed (Table 4). Average and maximum design flows and downstream impairments are included in the facility summaries. Nine facilities drain directly to impaired segments, and two discharge to small tributaries of impaired segments that are close to the impaired segment. The majority of the remaining facilities discharge to upstream unimpaired tributaries and likely do not contribute to project impairments. Relevant facilities include five municipal wastewater, four industrial wastewater, and two public water supply facilities.

Industrial facilities discharging to impaired segments include active coal mining facilities: Dynegy Midwest Generation – Baldwin (IL0000043), ExxonMobil Coal USA, Inc. – Monterey Coal Company No. 2 Mine (IL0076317), Hillside Recreational Lands, LLC – Randolph Preparation Plant (IL0062740), and Prairie State Generation Company – Marissa (IL0076996). All facilities have permitted limits for iron that are higher than the general use water quality standard and potentially may contribute to project impairments.

Table 4. Individual NPDES permitted facilities in impairment watersheds

IL Permit ID	Facility Name	Type of Discharge	Receiving Water	Downstream Impairment(s)	Average Design Flow (MGD)	Maximum Design Flow (MGD)
IL0026948	*Adorers of the Blood of Christ*	*STP*	*Unnamed tributary to Horse Creek*	*O-30*	*0.03*	*0.114*
ILG580017	*Albers STP*	*STP*	*Albers Creek*	*O-20, O-03, O-30*	*0.0907*	*0.227*
ILG580004	*Alhambra STP*	*STP*	*Unnamed tributary to Silver Creek*	*O-03, O-30*	*0.0725*	*0.288*
ILG640029	*Alhambra WTP*	*Public water supply*	*Unnamed tributary to Silver Creek*	*O-03, O-30*	*0.008* [a]	–
IL0020001	*Aviston STP*	*STP*	*Lake Branch*	*O-20, O-03, O-30*	*0.167*	*0.35*
IL0027219	*Baldwin STP*	*STP*	*Unnamed tributary to Plum Creek*	*O-30*	*0.051*	*0.128*
IL0021873	*Belleville STP #1*	*STP*	*Richland Creek*	*O-30*	*12.4* [b]	*27* [b]
IL0021083	*Caseyville Township East STP*	*STP (excess flow outfall)*	*Ellen Creek*	*O-03, O-30*	*4.4*	*11.39*
IL0075388	*Castle Ridge Estates STP*	*STP*	*Unnamed tributary to Mill Creek*	*O-20, O-03, O-30*	*0.0175*	*0.0735*
IL0029173	*City of Highland STP*	*STP (excess flow outfall)*	*Lidenthal Creek to Sugar Creek*	*O-20, O-03, O-30*	*1.6*	*4*
ILG840004	*Columbia Quarry Company - Waterloo Pit 7*	*Pit pumpage and stormwater*	*Rockhouse Creek*	*O-30*	*0.61* [a]	–
ILG640056	*Coulterville WTP*	*Public water supply*	*Unnamed tributary to South Fork Mud Creek*	*O-03, O-30*	*0.02* [a]	–
IL0063762	*Damiansville STP*	*STP*	*Unnamed tributary to Sugar Creek*	*O-20, O-03, O-30*	*0.06*	*0.234*
IL0046663	*Dutch Hollow Village - STP*	*STP*	*Unnamed tributary to Schoenburg Creek*	*O-30*	*0.08*	*0.2*
IL0000043	**Dynegy Midwest Generation - Baldwin**	*Ash pond discharge and overflow from cooling pond*	*Kaskaskia River*	*O-30*	–	*1,760* [b]
		Coal pile runoff	**Doza Creek**	**OZD, O-30**	**0.6**	**–**
ILG580145	*Ellis Grove STP*	*STP*	*Unnamed tributary to Little Ninemile Creek*	*O-30*	*0.0247*	*0.041*
IL0067695	*Enable Mississippi River Transmission, LLC - St. Jacob Station*	*Compressor and turbine building pit pumpage and stormwater*	*Unnamed ditch tributary to Little Silver Creek*	*O-03, O-30*	*0.000118*	–
IL0021440	**Evansville STP**	**STP**	**Kaskaskia River**	**O-30**	**0.17**	**0.425**
IL0076317	**ExxonMobil Coal USA, Inc. - Monterey Coal Company No. 2 Mine**	**Acid mine drainage**	**Kaskaskia River**	**O-20, O-03, O-30**	**1.4** [a]	**–**

IL Permit ID	Facility Name	Type of Discharge	Receiving Water	Downstream Impairment(s)	Average Design Flow (MGD)	Maximum Design Flow (MGD)
IL0020893	**Fayetteville STP**	**STP**	**Kaskaskia River**	**O-03, O-30**	**0.05**	**0.199**
IL0020753	*Freeburg East STP*	*STP*	*Lemen Creek to Silver Creek*	*O-03, O-30*	*0.31*	*0.775*
IL0032310	*Freeburg West STP*	*STP (excess flow outfall)*	*Kinney Branch of Richland Creek*	*O-30*	*0.4*	*1*
ILG580011	*Hamel STP*	*STP*	*Unnamed tributary to Silver Creek*	*O-03, O-30*	*0.105*	*0.263*
ILG580235	*Hecker STP*	*STP*	*Unnamed tributary to Hecker Creek*	*O-30*	*0.08*	*0.12*
ILG640044	*Highland WTP*	*Public water supply*	*Highland Silver Lake*	*ODL-02, O-03, O-30*	*0.03* [a]	*–*
IL0062740	**Hillside Recreational Lands, LLC - Randolph Preparation Plant**	**Acid and alkaline mine drainage and stormwater**	**Doza Creek**	**OZD, O-30**	**0.85** [a]	**–**
ILG551027	*Illinois DOT-I70 Madison County Rest Area*	*STP*	*Unnamed tributary to Sugar Creek*	*O-20, O-03, O-30*	*0.028*	*0.072*
ILG640077	**Kaskaskia Water District WTP**	**Public water supply**	**Kaskaskia River**	**O-03, O-30**	**0.84** [a]	**–**
IL0029483	*Lebanon STP*	*STP*	*Little Silver Creek*	*O-03, O-30*	*0.87*	*1.3*
ILG580013	*Lenzburg STP*	*STP*	*Unnamed tributary of Doza Creek*	*OZD, O-30*	*0.0825*	*0.165*
ILG580115	*Livingston STP*	*STP*	*Unnamed tributary to Silver Creek*	*O-03, O-30*	*0.148*	*0.667*
IL0074993	*Manors at Kensington Parque STP*	*STP*	*Unnamed tributary of Wendell Branch*	*O-03, O-30*	*0.0238*	*0.0595*
IL0071579	*Maple Leaf Estates Water Corp*	*Common collector outfall*	*Unnamed tributary to Richland Creek*	*O-30*	*0.0127*	*0.0381*
ILG580228	*Marine STP*	*STP*	*Marine Effluent Creek*	*O-03, O-30*	*0.24*	*0.66*
IL0024813	**Marissa STP** [c]	**STP**	**Unnamed tributary of Doza Creek**	**OZD, O-30**	**0.585**	**2.54**
IL0025291	*Mascoutah STP*	*STP*	*Silver Creek*	*O-03, O-30*	*0.965*	*2.972*
IL0075094	*Metro-East Airpark STP*	*STP*	*Unnamed tributary of Silver Creek*	*O-03, O-30*	*0.0042*	*0.015*
IL0032514	*Millstadt STP*	*STP*	*Douglas Creek*	*O-30*	*0.965*	*1.838*
IL0021725	**New Athens STP**	**STP (excess flow outfall)**	**Kaskaskia River**	**O-03, O-30**	**0.3**	**0.75**
IL0032603	*New Baden STP*	*STP*	*Unnamed tributary of Sugar Creek*	*O-20, O-03, O-30*	*0.78*	*1.349*
IL0076732	*New Memphis Sanitary District STP*	*STP*	*Unnamed tributary of Queens Lake Branch*	*O-20, O-03, O-30*	*0.035*	*0.14*
IL0021636	*O'Fallon STP*	*STP*	*Silver Creek*	*O-03, O-30*	*5.61*	*13.14*

IL Permit ID	Facility Name	Type of Discharge	Receiving Water	Downstream Impairment(s)	Average Design Flow (MGD)	Maximum Design Flow (MGD)
ILG580137	*Pierron West STP*	*STP*	*Unnamed tributary to Sugar Creek*	*O-20, O-03, O-30*	*0.0429*	*0.172*
IL0076996	**Prairie State Generation Company - Marissa**	**Cooling tower blowdown and runoff/sedimentation pond outfall (emergency overflow)**	**Kaskaskia River**	**O-03, O-30**	**3.158** [b]	**–**
IL0025348	*Red Bud STP*	*STP (excess flow outfall)*	*Black Creek*	*O-30*	*0.6*	*1.2*
IL0063282	*Ruma WWTP*	*STP*	*Ruma Creek*	*O-30*	*0.04*	*0.16*
IL0026859	*Scott Air Force Base*	*STP (excess flow outfall)*	*Unnamed tributary of Silver Creek*	*O-03, O-30*	*4* [b]	*6* [b]
IL0020834	*Smithton STP*	*STP*	*Douglas Creek*	*O-30*	*0.95*	*2.85*
IL0066133	*Sparta NW STP*	*STP*	*Sparta Creek*	*O-30*	*0.25*	*0.62*
IL0048232	*St. Clair Township - Lincolnshire STP*	*STP (excess flow outfall)*	*Loop Creek*	*O-03, O-30*	*1.5*	*3.75*
ILG580212	**St. Jacob STP** [c]	**STP**	**St. Jacob Creek**	**ODL-02, O-03, O-30**	**0.14**	**0.35**
ILG640162	*St. Libory WTP*	*Public water supply*	*Unnamed tributary to Little Mud Creek*	*O-03, O-30*	*0.004* [a]	*–*
ILG580014	*St. Libory WWTP*	*STP*	*Little Mud Creek*	*O-03, O-30*	*0.09*	*0.225*
ILG580002	*St. Rose Sanitary District STP*	*STP*	*Unnamed tributary to Lake Branch-East*	*O-20, O-03, O-30*	*0.039*	*0.53*
ILG640083	*St. Rose WTP*	*Public water supply*	*Bull Branch*	*O-20, O-03, O-30*	*0.004* [a]	*–*
IL0064220	*Summerfield STP*	*STP*	*Unnamed tributary of Little Silver Creek*	*O-03, O-30*	*0.07*	*0.245*
ILG640032	**Summerfield, Lebanon, and Mascoutah WTP**	**Public water supply**	**Kaskaskia River**	***O-20, O-03, O-30***	**0.16** [a]	**–**
IL0021181	*Swansea STP*	*STP (excess flow outfall)*	*Richland Creek*	*O-30*	*5.015*	*11.89*
ILG580107	*Tilden STP*	*STP*	*Unnamed tributary to Plum Creek-South*	*O-30*	*0.111*	*0.275*
ILG551050	*Timber Lakes Mobile Home Park STP*	*STP*	*Rockhouse Creek*	*O-30*	*0.0068*	*0.017*
IL0026701	*Trenton STP*	*STP*	*Trenton Creek*	*O-20, O-03, O-30*	*0.5*	*1.25*
ILG551025	*Triad High School District 2 STP*	*STP*	*Silver Creek*	*O-03, O-30*	*0.0195*	*0.048*

IL Permit ID	Facility Name	Type of Discharge	Receiving Water	Downstream Impairment(s)	Average Design Flow (MGD)	Maximum Design Flow (MGD)
IL0031488	*Troy STP*	*STP (excess flow outfall)*	*Troy Creek, Wendel Branch*	*O-03, O-30*	*1.35*	*3.902*
ILG640033	*Troy WTP*	*Public water supply*	*Troy Creek, Wendel Branch*	*O-03, O-30*	*0.11* [a]	*–*
ILG551011	*Wesclin High School District 3 STP*	*STP*	*Unnamed tributary to Sugar Creek*	*O-20, O-03, O-30*	*0.02*	*0.05*

Italics – NPDES facility draining to unimpaired segment.
BOLD – NPDES facility draining to impaired segment.
MGD – Million gallons per day
STP – Sewage treatment plant
WTP – Water treatment plant
WWTP – Wastewater treatment plant
a. Average design flow based on average reported flow from 2014–2016 discharge monitoring records (DMRs).
b. Flow listed includes multiple outfalls.
c. Although Marissa STP and St. Jacob STP do not discharge directly to an impaired segment, they discharge to small tributaries of impaired segments and could potentially contribute to the low dissolved oxygen impairments on Doza Creek OZD and East Fork Silver Creek ODL-02, respectively.

3.2.2 Municipal Separate Storm Sewer Systems

Regulated stormwater runoff can contribute to impairments in the project area. As development increases in the watershed, additional pressure will be placed on receiving waters due to stormwater. Impervious areas associated with developed land uses can result in higher peak flow rates, higher runoff volumes, and larger pollutant loads. Stormwater runoff often contains sediment and nutrients, among other pollutants.

Under the NPDES program, municipalities serving populations over 100,000 people are considered Phase I MS4 communities. In the impairment watersheds, there are no Phase I communities. Municipalities serving populations under 100,000 people are considered Phase II communities. In Illinois, Phase II communities are allowed to operate under the statewide General Storm Water Permit (ILR40), which requires dischargers to file a Notice of Intent acknowledging that discharges shall not cause or contribute to a violation of water quality standards.

To assure pollution is controlled to the maximum extent practical, regulated entities operating under the General Storm Water Permit (ILR40) are required to implement six control measures including public education, public involvement, illicit discharge and detection programs, control of construction site runoff, post construction stormwater management in new development and redevelopment, and pollution prevention/good housekeeping for municipal operations. Regulated entities operating under the General Storm Water Permit in the impairment watersheds are identified in Table 5.

Table 5. Permitted MS4s in impairment watersheds

Permit ID	Regulated Entity	Downstream Receiving Waters
ILR400290	Belleville City MS4	Kaskaskia River (O-03 and O-30)
ILR400527	Belleville Township MS4	Kaskaskia River (O-03 and O-30)
ILR400024	Caseyville Township MS4	Kaskaskia River (O-03 and O-30)
ILR400318	Columbia City MS4	Kaskaskia River (O-30)
ILR400186	Edwardsville City MS4	Kaskaskia River (O-03 and O-30)
ILR400045	Edwardsville Township MS4	Kaskaskia River (O-03 and O-30)
ILR400190	Fairview Heights City MS4	Kaskaskia River (O-03 and O-30)
ILR400197	Glen Carbon Village MS4	Kaskaskia River (O-03 and O-30)
ILR400070	Jarvis Township MS4	East Fork Silver Creek (ODL-02) and Kaskaskia River (O-03 and O-30)
ILR400549	Lebanon City MS4	Kaskaskia River (O-03 and O-30)
ILR400587	Lebanon Township MS4	Kaskaskia River (O-20, O-03, and O-30)
ILR400263	Madison County MS4	Kaskaskia River (O-03 and O-30)
ILR400522	Marine Township MS4	Sugar Fork (ODLA-01), East Fork Silver Creek (ODL-02) and Kaskaskia River (O-03 and O-30)
ILR400488	Mascoutah City MS4	Kaskaskia River (O-03 and O-30)
ILR400591	Mascoutah Township MS4	Kaskaskia River (O-20, O-03, and O-30)
ILR400110	Pin Oak Township MS4	Kaskaskia River (O-03 and O-30)
ILR400124	Shiloh Valley Township MS4	Kaskaskia River (O-03 and O-30)
ILR400275	Shiloh Village MS4	Kaskaskia River (O-03 and O-30)
ILR400270	St Clair County MS4	Kaskaskia River (O-03 and O-30)
ILR400135	Stookey Township MS4	Kaskaskia River (O-30)
ILR400137	Sugar Loaf Township MS4	Kaskaskia River (O-30)
ILR400458	Swansea Village MS4	Kaskaskia River (O-30)

Permit ID	Regulated Entity	Downstream Receiving Waters
ILR400461	Troy City MS4	Kaskaskia River (O-03 and O-30)
ILR400493	Illinois Department of Transportation (road authority)	Kaskaskia River (O-03 and O-30)

3.2.3 CAFOs

The area that produces manure, litter, or processed wastewater as the result of CAFOs is considered a point source that is regulated through the NPDES Program. In Illinois, the CAFO program is administered by the Illinois EPA through general permit number ILA01 (refer to http://www.epa.state.il.us/water/cafo/ for more details). The federal regulations for all CAFOs can be found in 40 CFR Parts 9, 122, and 412. U.S. EPA requires that CAFOs receive a wasteload allocation as part of the TMDL development process; the wasteload allocation is typically set at zero for all pollutants. There are five CAFOs in the Lower Kaskaskia River watershed (Table 6). All facilities drain to unimpaired tributaries upstream of impaired segments.

Table 6. CAFOs

Permit ID	Regulated Entity	Receiving Waters
ILA010072	Westridge Dairy, LLC	Kaskaskia River (O-30)
ILA010077	CD & R Farms Inc.	Kaskaskia River (O-20, O-03, and O-30)
ILA010089	Robert Mondt Dairy	
ILA010097	Elm Farms, Inc.	
ILA010102	KHMM Range Farm	Kaskaskia River (O-03 and O-30)

3.3 Nonpoint Sources

The term nonpoint source pollution is defined as any source of pollution that does not meet the legal definition of point sources. Nonpoint source pollution typically results from overland stormwater runoff that is diffuse in origin, as well as background conditions. It should be noted that stormwater collected and conveyed through a regulated MS4 is considered a controllable point source. As part of the water resource assessment process, Illinois EPA identified several sources as contributing to the Middle Kaskaskia River watershed impairments (Table 7).

Table 7. Potential sources in project area based on the draft 2016 305(b) list

Watershed	Segment	Sources
Kaskaskia River	IL_O-03	Channelization, dredging (e.g. for navigation channels), animal feeding operations and livestock grazing, municipal point source discharges, drainage/filling/loss of wetlands, crop production (crop land or dry land), agriculture and source unknown
	IL_O-20	Animal feeding operations, loss of riparian habitat, crop production (crop land or dry land), agriculture, urban runoff/storm sewers and source unknown
	IL_O-30	Crop production (crop land or dry land) and source unknown
East Fork Silver Creek	IL_ODL-02	Crop production (crop land or dry land) and agriculture
Sugar Fork	IL_ODLA-01	Animal feeding operations and livestock grazing, irrigated crop production, agriculture and petroleum/natural gas activities
Doza Creek	IL_OZD	Impacts from abandoned mine lands (inactive), municipal point source discharges, drainage/filling/loss of wetlands and crop production (crop land or dry land)

A summary of the potential nonpoint sources of pollutants is provided below, and additional information on the primary pollutant sources follows.

- Nonpoint sources potentially contributing to low dissolved oxygen conditions include stormwater and agricultural runoff (including runoff from abandoned mine lands), onsite wastewater treatment systems, animal agriculture activities, sediment oxygen demand, channelization, and hydrologic modification (dam or impoundment). Typical pollutants of concern include phosphorus (leading to eutrophication), ammonia, and carbonaceous biochemical oxygen demand. Sediment oxygen demand, often a result of decaying organic matter, can significantly contribute to low dissolved oxygen conditions. Channelization and hydrologic modification are non-pollutant sources. Channelization can result in low dissolved oxygen conditions due to lack of in-stream structures that would reaerate the water column.
- Nonpoint sources potentially contributing to high iron concentrations include stormwater runoff, agricultural runoff, and stream channel erosion.
- Nonpoint sources potentially contributing to high manganese concentrations include erosion potentially from agriculture and abandoned mine lands.

3.3.1 Animal Feeding Operations (AFOs)

Animal feeding operations that are not classified as CAFOs are known as animal feeding operations (AFOs) in Illinois. Non-CAFO AFOs are considered nonpoint sources by U.S. EPA. AFOs in Illinois do not have state permits. However, they are subject to state livestock waste regulations and may be inspected by the Illinois EPA, either in response to complaints or as part of the agency’s field inspection responsibilities to determine compliance by facilities subject to water pollution and livestock waste regulations. The animals raised in AFOs produce manure that is stored in pits, lagoons, tanks, and other storage devices. The manure is then applied to area fields as fertilizer. When stored and applied properly, this beneficial re-use of manure provides a natural source for crop nutrition. It also lessens the need for fuel and other natural resources that are used in the production of fertilizer. AFOs, however, can pose environmental concerns, including the following:

- Manure can leak or spill from storage pits, lagoons, tanks, etc.
- Improper application of manure can contaminate surface or ground water.
- Manure over application can adversely impact soil productivity.

Livestock are potential sources of nutrients to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. However, county wide data available from the 2012 Census of Agriculture were downloaded and area weighted to estimate the animal population in the project area. An estimated 113,528 animals are in the project area.

Additional relevant information for this section can be found in the Lower Kaskaskia River Watershed Total Maximum Daily Load report (IEPA 2012).

3.3.2 Onsite Wastewater Treatment Systems

Onsite wastewater treatment systems (e.g., septic systems) that are properly designed and maintained should not serve as a source of contamination to surface waters. However, onsite systems do fail for a variety of reasons. Common soil-type limitations that contribute to failure include seasonally high water tables, compact glacial till, bedrock, and fragipan. When these septic systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration) there can be adverse effects to surface waters (Horsley and Witten, Inc. 1996). Septic systems contain all the water discharged from homes and business and can be significant sources of pollutants. County health departments were contacted for information on septic systems and unsewered communities. Responses were received from Bond, Montgomery, Randolph, and St. Clair counties. St. Clair county estimates that 10,000–12,000 installed septic systems are present in the county. Montgomery county reported 14,061 new septic systems installed since 2007. Bond and Randolph counties reported that inspections of newly installed septic systems are required, but the counties do not have a total count of installed systems or unsewered communities. Information was not provided on failure rates or results of compliance testing.

Additional relevant information for this section can be found in the Lower Kaskaskia River Watershed Total Maximum Daily Load report (IEPA 2012).

3.3.3 Stormwater and Agricultural Runoff

During wet-weather events (snowmelt and rainfall), pollutants are incorporated into runoff and can be delivered to downstream waterbodies. The resultant pollutant loads are linked to the land uses and practices in the watershed. Agricultural and developed areas can have significant effects on water quality if proper best management practices are not in place.

In addition to pollutants, alterations to a watershed's hydrology as a result of land use changes, ditching, and stream channelization can detrimentally affect habitat and biological health. Imperviousness associated with developed land uses and agricultural field tiling can result in increased peak flows and runoff volumes and decreased base flow as a result of reduced ground water discharge. Drain tiles also transport agricultural runoff directly to ditches and streams, whereas runoff flowing over the land surface may infiltrate to the subsurface and may flow through riparian areas.

3.3.4 Stream Channel and Shoreline Erosion

Various forms of erosion are a common source of sediment and associated pollutants. Erosion may contribute to impairments because iron and nutrients are often sorbed to sediment. Bank and channel erosion refers to the wearing away of the banks and channel of a stream or river. High rates of bank and channel erosion can often be associated with water flow and sediment dynamics that are out of balance. This can result from land use activities that either alter flow regimes, adversely affect the floodplain and streamside riparian areas, or a combination of both. Specific information on channel alteration and erosional processes in the East Fork Silver Creek watershed and along the Kaskaskia River can be found in the Aerial Assessment Report on Highland Silver Lake and East Fork of Silver Creek (Limno Tech 2005) and the Bank Erosion Study of the Kaskaskia River, Carlyle Lake to New Athens, Illinois (USACE 2000), respectively.

4. Water Quality

Background information on water quality monitoring can be found in the Lower Kaskaskia River Watershed Total Maximum Daily Load report (IEPA 2012). In the Lower Kaskaskia River watershed, water quality data were found for numerous stations that are part of the Illinois EPA Ambient Water Quality Monitoring Network (AWQMN) and at USGS gage 05595000 (Kaskaskia River at New Athens, IL). Monitoring stations with data relevant to the impaired segments are presented in Figure 1 and Table 8. Parameters sampled in the streams include field measurements (e.g., water temperature) as well as those that require lab analyses (e.g., nutrients, chloride).

The most recent 10 years of data collection, 2007–2016, were used to evaluate impairment status. Data that are greater than 10 years old are only included for impairments that were not verified with data from

2007–2016. Each data point was reviewed to ensure the use of quality data in the analyses below. Data were obtained directly from Illinois EPA and from the USGS National Water Information System (NWIS).

Table 8. Lower Kaskaskia River watershed water quality data

Waterbody	Impaired Segment	AWQMN Sites (USGS Gage)	Location	Period of Record
Kaskaskia River	O-03	O-03 (05595000)	RM 29.2, Route 13 bridge New Athens	*2002*, 2007, 2012–2016
		O-91	RM 36.5, Route 15 bridge Fayetteville	2007
		O-55	Pike Sawmill Rd. 4 Mi. SW of New Athens	*2005*
	O-20	O-20	RM 57.2, Route 177 bridge 5 Mi. NW Okawville near Venedy Station	*1999–2006*, 2007–2016
	O-30	O-30	RM 3.3, Roots Rd. bridge 2.7 Mi. W of Ellis Grove	*1999–2006*, 2007–2016
East Fork Silver Creek	ODL-02	ODL-02	1.5 Mi. NW St. Jacob	*2002*, 2007, 2012
Sugar Fork	ODLA-01	ODLA-01	1 Mi. E Marine	2007
Doza Creek	OZD	OZD-01	4 Mi. S New Athens	2007
		OZD-MA-C1	NW edge of Marissa, 0.2 Mi. DNS Marissa WWTP outfall	2007
		OZD-MA-C2	1 Mi. W Marissa along railroad	2007

Italics – Data are more than 10 years old
DNS – Downstream
RM – River Mile

An important step in the TMDL development process is the review of water quality conditions, particularly data and information used to list segments. Examination of water quality monitoring data is a key part of defining the problem that the TMDL is intended to address. This section provides a brief review of available water quality information provided by the Illinois EPA and downloaded from USGS NWIS.

4.1 Kaskaskia River

The Kaskaskia River is listed as being impaired along three segments: O-20, O-03, and O-30 (listed from upstream to downstream). Segment O-03 is impaired for aquatic life due to low levels of dissolved oxygen. The upstream-most segment (O-20) is impaired for public and food processing water supply use due to high levels of iron, and the downstream-most segment (O-30) is impaired for aquatic life use, also due to high iron. Three Illinois EPA sampling sites are located along segment O-03, and there is one sampling site with relevant data along each of the remaining impaired reaches.

4.1.1 O-03

From 2007–2016, 456 dissolved oxygen measurements were collected at site O-03 (05595000), and one measurement was taken at O-91 (Table 9 and Figure 2). Violations of the general use water quality standard were observed during June 2007, July 2012, October 2015, and June through September 2016. Continuous dissolved oxygen data were collected at site O-03 in July 2012, during which time multiple violations of the standard were observed (Figure 3). Dissolved oxygen data were collected at site O-55 prior to 2007 and were not evaluated. Aquatic life use impairment is verified on this segment.

Dissolved oxygen data were paired with phosphorus and chlorophyll-*a* data to determine if eutrophication is contributing to low dissolved oxygen conditions. Data older than 10 years were included in the analysis based on the assumption that conditions have not changed along the segment. Strong correlations between phosphorus or chlorophyll-*a* and dissolved oxygen were not observed (Figure 4, Figure 5).

Table 9. Data summary, Kaskaskia River O-03

Sample Site	No. of samples	Minimum (mg/L)	Average (mg/L)	Maximum (mg/L)	Number of exceedances of general use water quality standard (>5 mg/L (Mar-Jul) and >3.5 mg/L (Aug-Feb))
Dissolved Oxygen					
O-03 (05595000)	456 [a]	2.1	9.0	15.2	17
O-91	1	8.1	8.1	8.1	0

a. Daily measurements from September 2015 through December 2016.

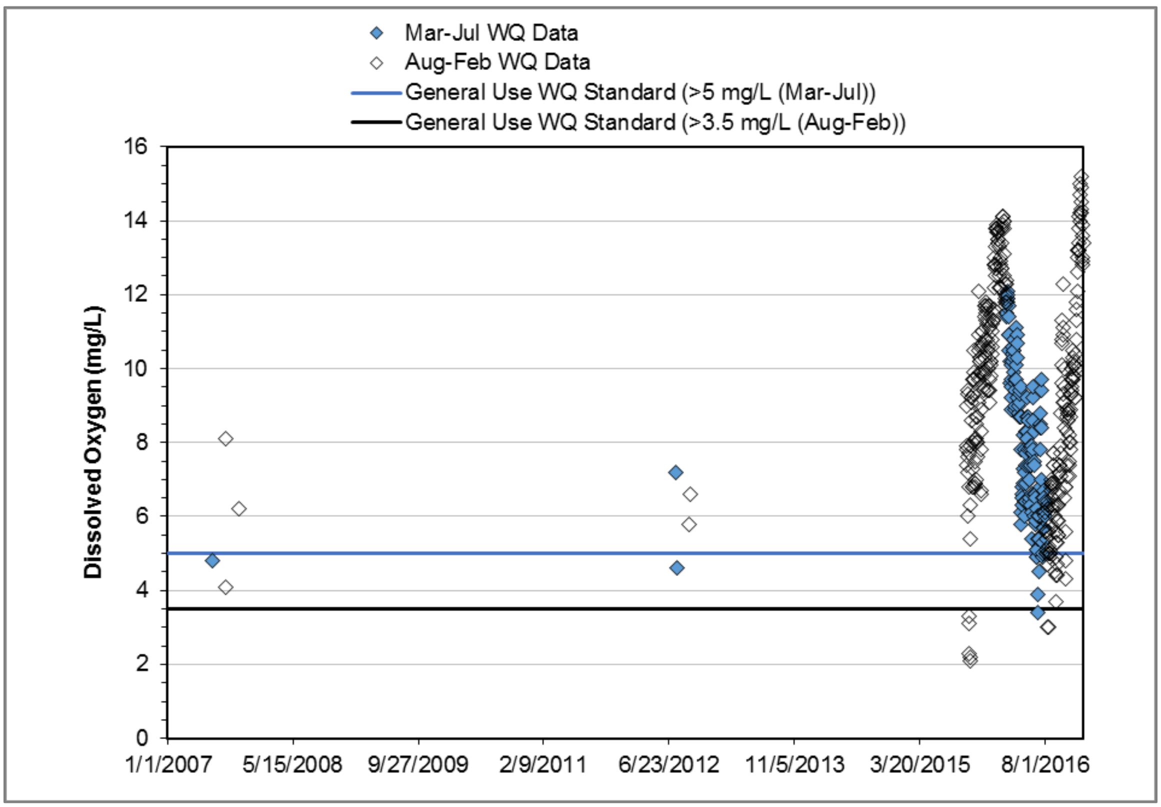

Figure 2. Dissolved oxygen water quality time series, Kaskaskia River O-03 segment.

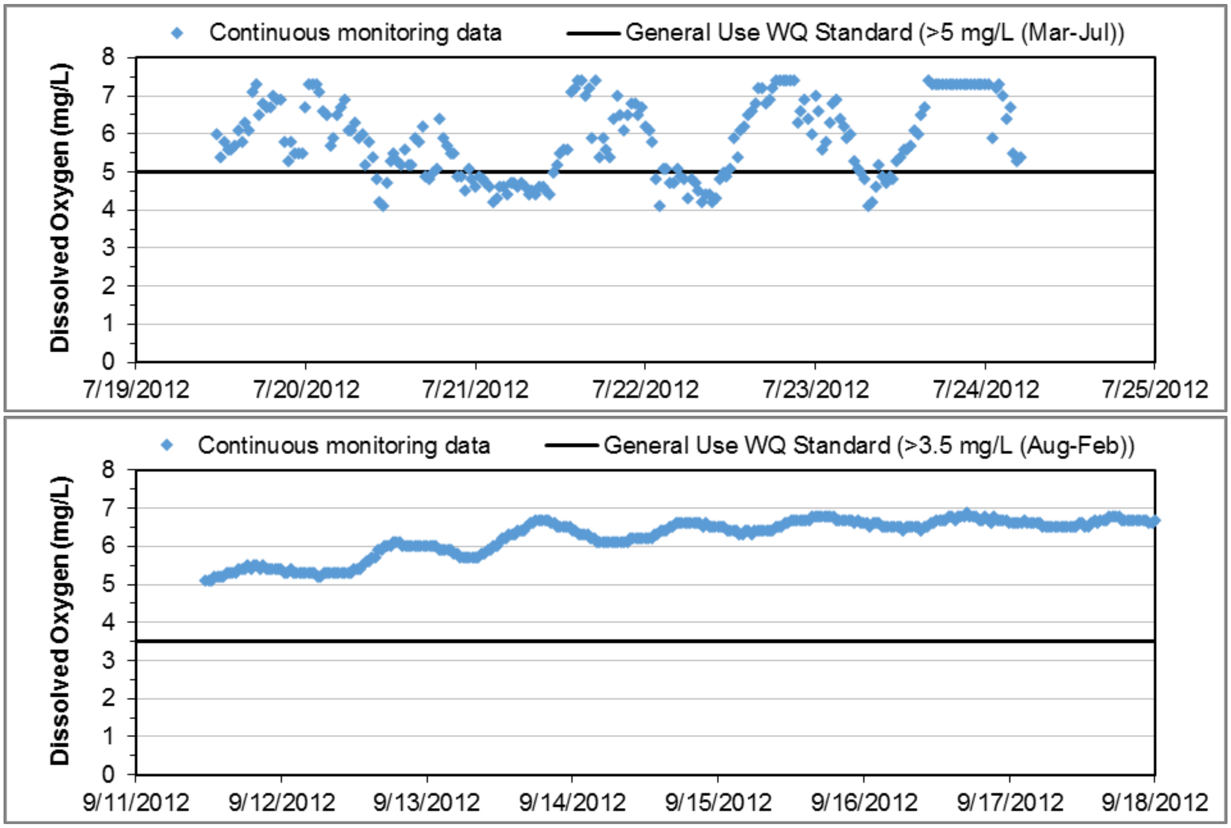

Figure 3. Continuous water quality time series for dissolved oxygen, Kaskaskia River O-03 segment (site O-03).

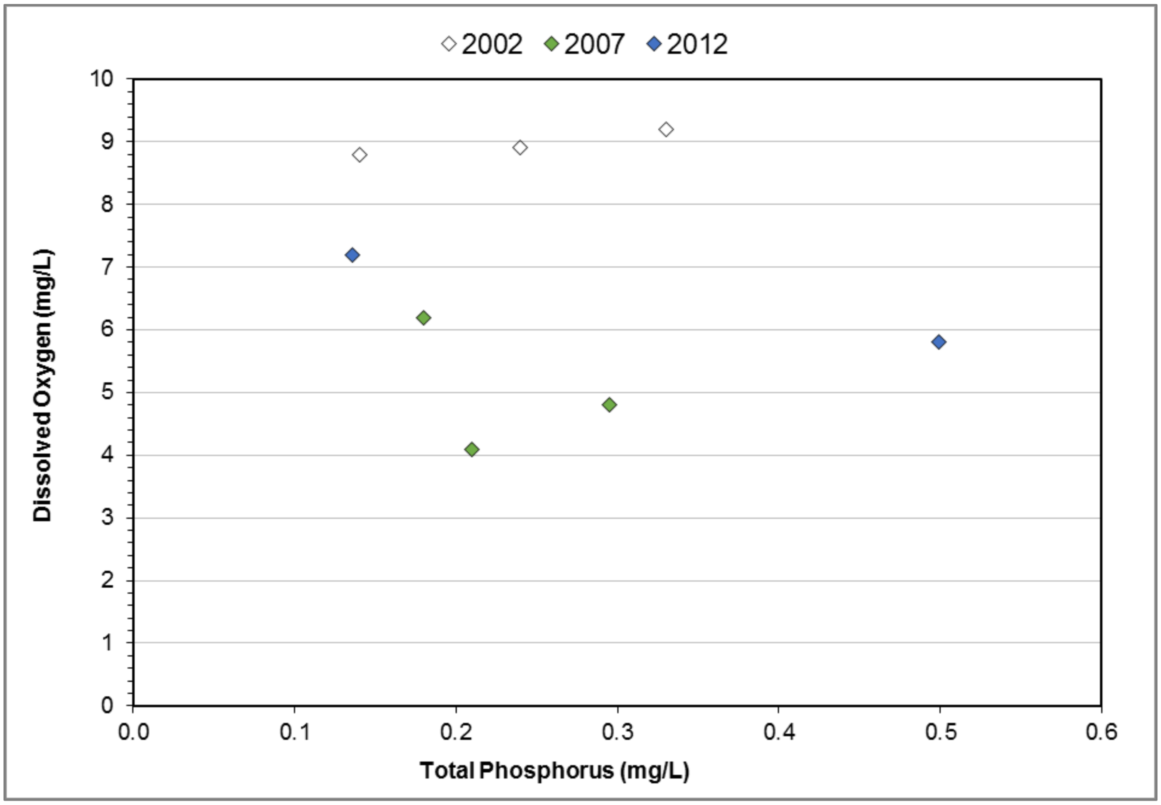

Figure 4. Total phosphorus versus dissolved oxygen, 2002–2012, Kaskaskia River O-03 segment.

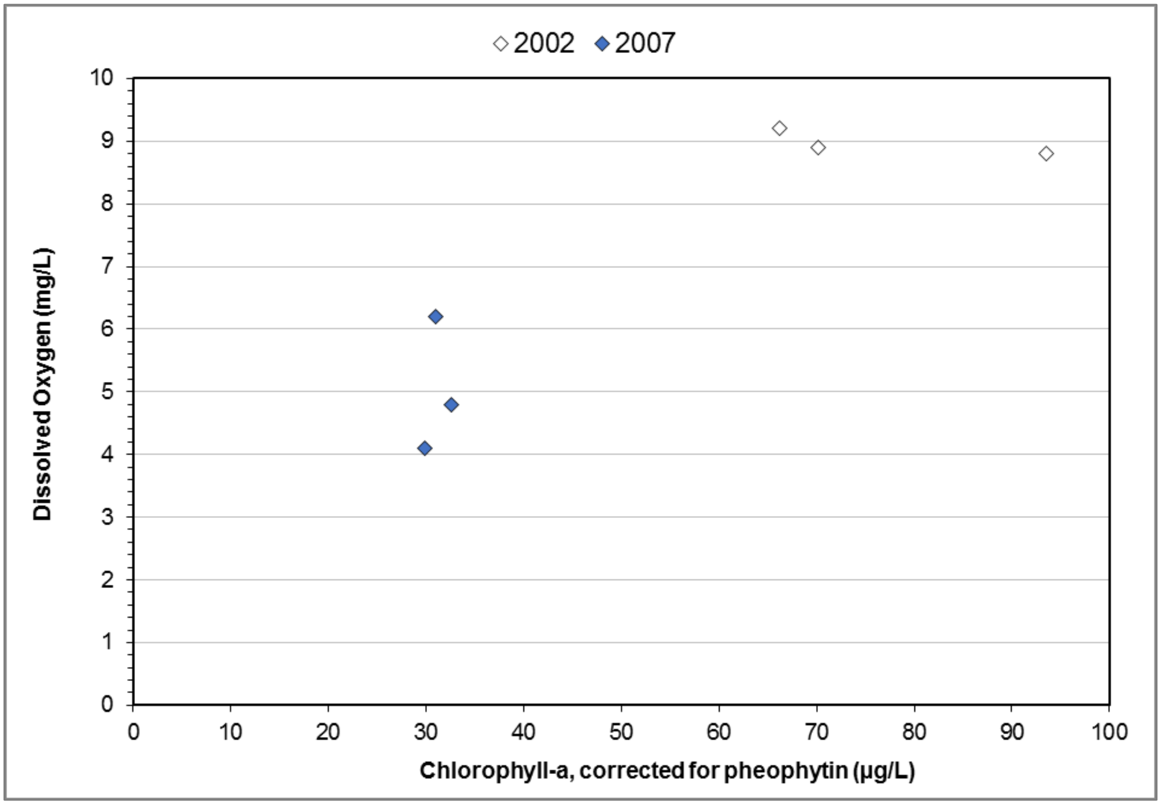

Figure 5. Chlorophyll-*a* versus dissolved oxygen, 2002–2007, Kaskaskia River O-03 segment.

4.1.2 O-20

From 2014–2016, 22 dissolved iron samples were collected at O-20 (Table 10 and Figure 6). Greater than 10 percent of samples were recorded above the 0.3 mg/L drinking water protection numeric standard. A sample in March of 2016 also exceeded the MCL of 1 mg/L. Public and food processing water supply use impairment is verified on this segment.

Table 10. Iron data summary, Kaskaskia River O-20

Sample Site	Date	Result (mg/L)	Quarterly Average (mg/L)
Iron, dissolved			
O-20	1/21/2014	0.03	0.21
	2/20/2014	0.58	
	3/31/2014	0.01	
	5/14/2014	0.03	0.03
	6/16/2014	0.03	
	8/11/2014	0.04	0.04
	9/8/2014	0.04	
	10/8/2014	0.06	0.28
	12/8/2014	0.49	
	1/28/2015	0.05	0.07
	3/18/2015	0.09	
	4/21/2015	0.03	0.19
	5/12/2015	0.51	
	6/25/2015	0.03	
	8/10/2015	0.07	0.04
	9/8/2015	0.01	
	10/22/2015	0.04	0.20
	12/2/2015	0.36	
	1/6/2016	0.09	0.66
	3/2/2016	**1.22**	
	4/4/2016	0.10	0.21
	5/10/2016	0.33	

Red values indicate samples exceeding the Public and Food Processing Water Supply Standard
Bold red values indicate samples exceeding the Public and Food Processing Water Supply Standard and above the MCL

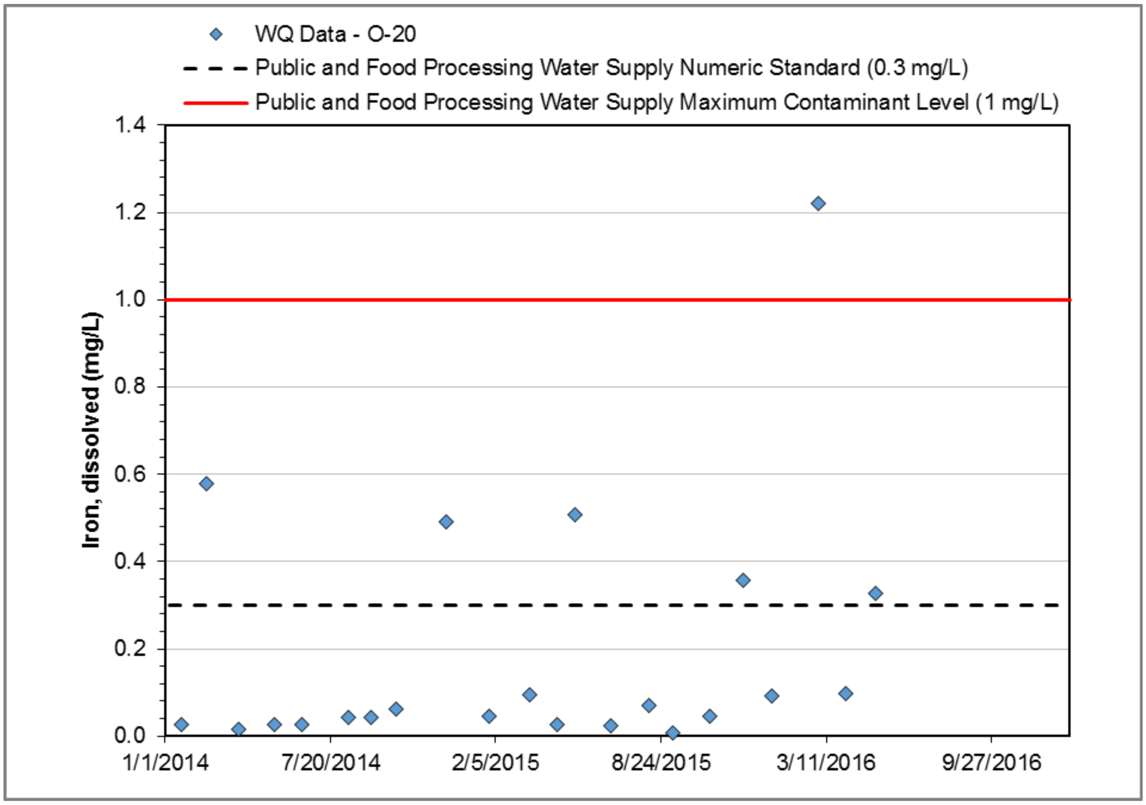

Figure 6. Iron water quality time series, Kaskaskia River O-20 segment.

4.1.3 O-30

From 2007–2016, 77 dissolved iron samples were collected at O-30 (Table 11 and Figure 7). Violations of the general use water quality standard were observed in June 2011 and January 2013. Aquatic life use impairment is verified on this segment.

Table 11. Data summary, Kaskaskia River O-30

Sample Site	No. of samples	Minimum (mg/L)	Average (mg/L)	Maximum (mg/L)	Number of exceedances of general use water quality standard (1,000 µg/L)
Iron, dissolved					
O-30	77	2	178	4,780	2

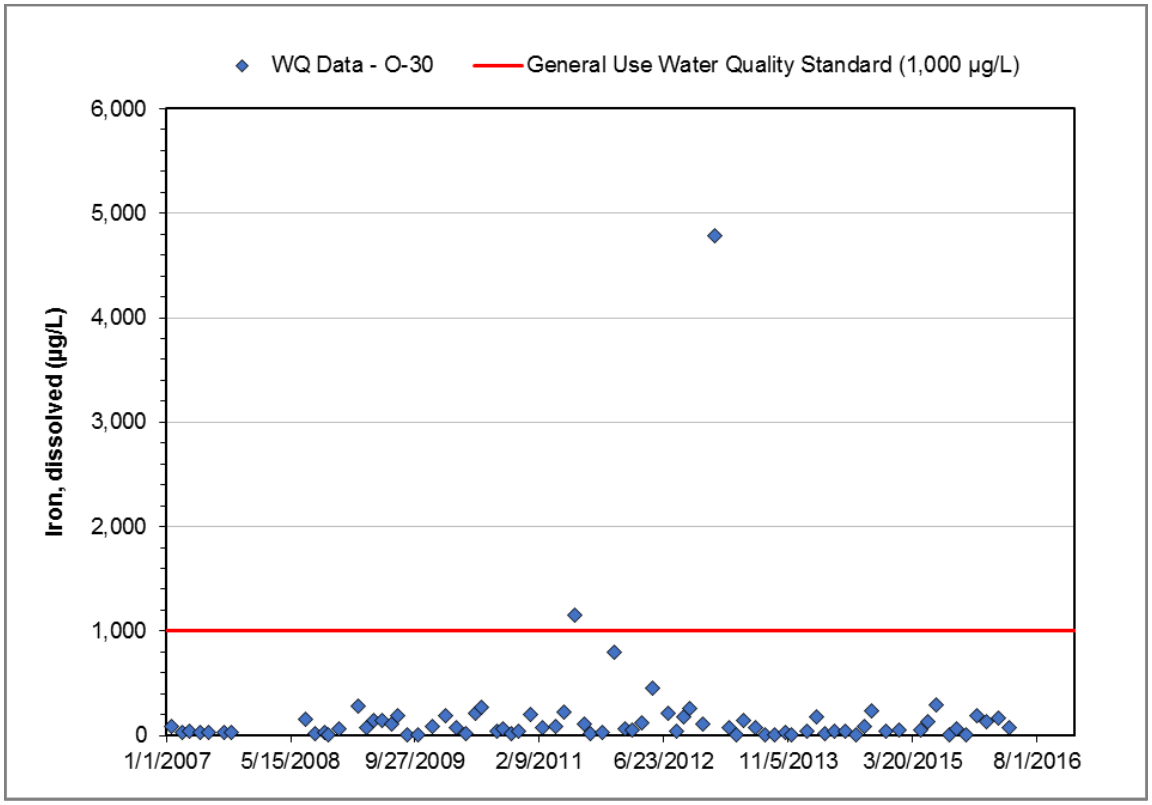

Figure 7. Iron water quality time series, Kaskaskia River O-30 segment.

4.2 East Fork Silver Creek (ODL-02)

East Fork Silver Creek ODL-02 is listed as impaired for aquatic life due to low dissolved oxygen. One Illinois EPA sampling site with relevant data was identified on East Fork Silver Creek, ODL-02. Seven discrete samples were collected from 2007–2012 (Table 12 and Figure 8). Continuous monitoring data were collected in 2012 and 2017 (Figure 9). Violations of the general use water quality standard were observed in June 2007, May 2012, July 2012, June 2017, and September 2017. Aquatic life use impairment is verified on this segment.

Table 12. Summary of discrete data collection, East Fork Silver Creek ODL-02

Sample Site	No. of samples	Minimum (mg/L)	Average (mg/L)	Maximum (mg/L)	Number of exceedances of general use water quality standard (>5 mg/L (Mar-Jul) and >3.5 mg/L (Aug-Feb))
Dissolved Oxygen					
ODL-02	7	1.6	4.8	8.3	5

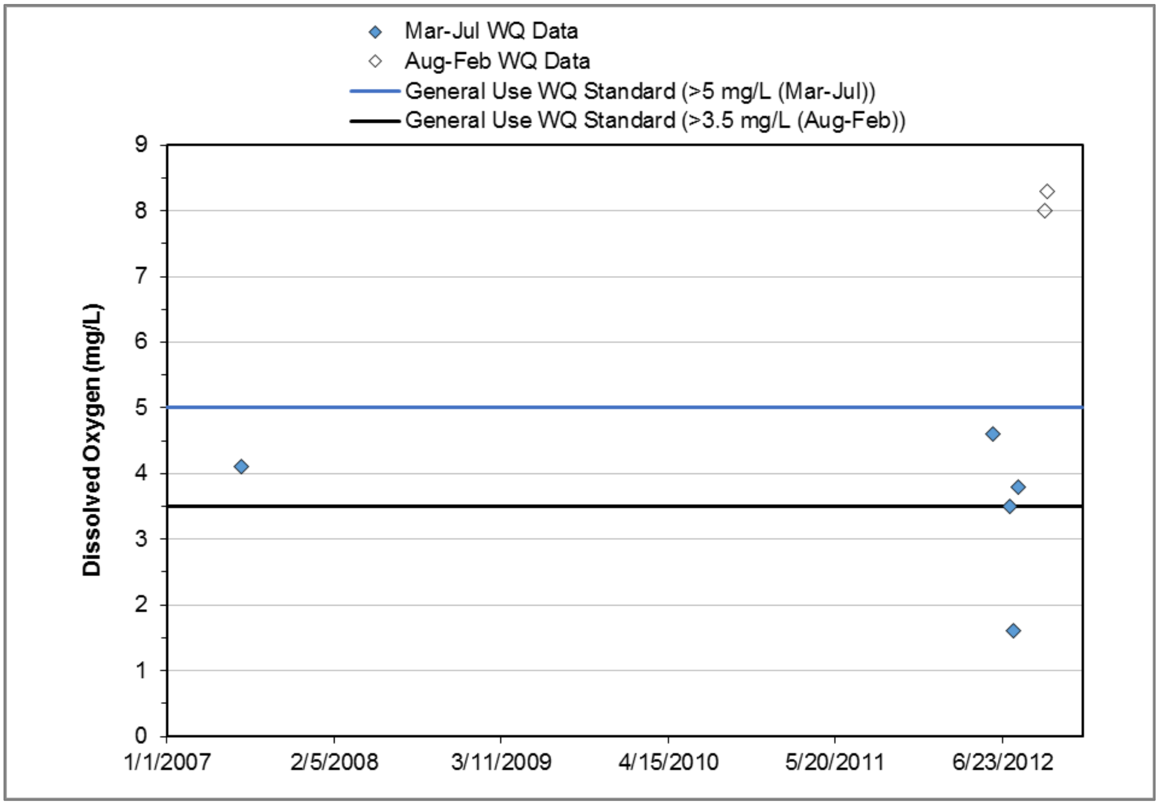

Figure 8. Dissolved oxygen water quality time series, East Fork Silver Creek ODL-02.

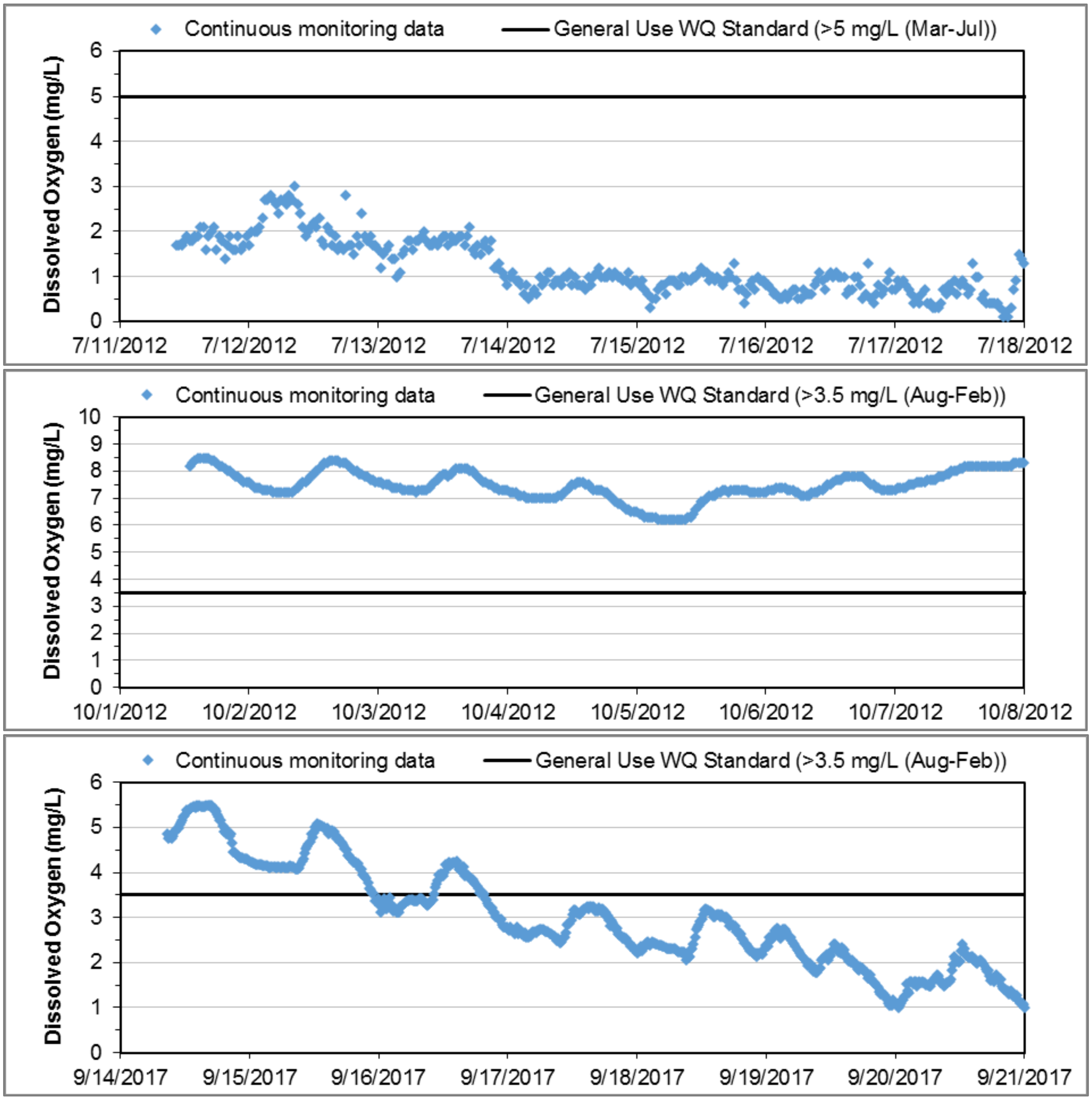

Figure 9. Continuous water quality time series for dissolved oxygen, East Fork Silver Creek ODL-02.
Continuous data were also provided for this site from June 21 through June 28, 2017. The data are not presented here because it appears that the sensor malfunctioned.

Further review of available data was conducted to determine the cause of impairment:

- **Point Sources:** There are no point sources that directly contribute to the impaired segment. All point sources are located upstream of the impaired segment and discharge into unimpaired segments based on available data. However, St. Jacob STP (ILG580212) discharges to a small tributary of East Fork Silver Creek and could potentially contribute to the ODL-02 low dissolved oxygen impairment.

- **Eutrophication:** Dissolved oxygen data were paired with phosphorus and chlorophyll-*a* data to determine if eutrophication is contributing to low dissolved oxygen conditions. Data older than 10 years were included in the analysis based on the assumption that conditions have not changed along the segment. As phosphorus concentrations increase, DO concentration decreases (Figure 10), suggesting that eutrophication might contribute to impairment. However, chlorophyll-*a* concentrations are not correlated with DO and are low, indicating that the segment is not eutrophic (Figure 11).

- **Physical Properties:** East Fork Silver Creek receives flow from Sugar Fork (ODLA-01) and Highland Silver Lake (ROZA). There is only one monitoring station on the segment with relevant data, downstream of the confluence with ODLA-01. Dissolved oxygen conditions at the outlet of both waterbodies could influence East Fork Silver Creek, and future monitoring should include a station upstream of the confluence of ODLA-01. Based on a review of aerial photos, much of the length of the creek has also been channelized and is surrounded by agriculture.

A strong link to a pollutant is not present. Additional data could be collected to further evaluate the cause and extent of impairment.

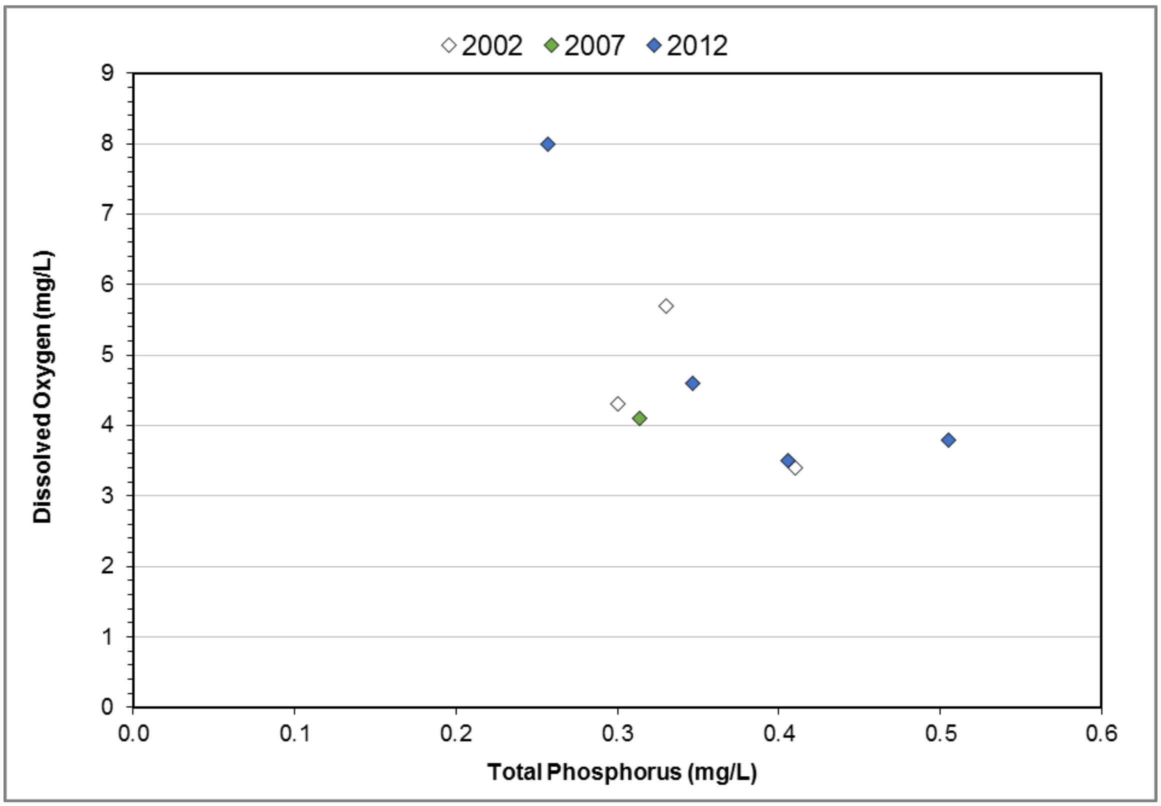

Figure 10. Total phosphorus versus dissolved oxygen, 2002–2012, East Fork Silver Creek ODL-02.

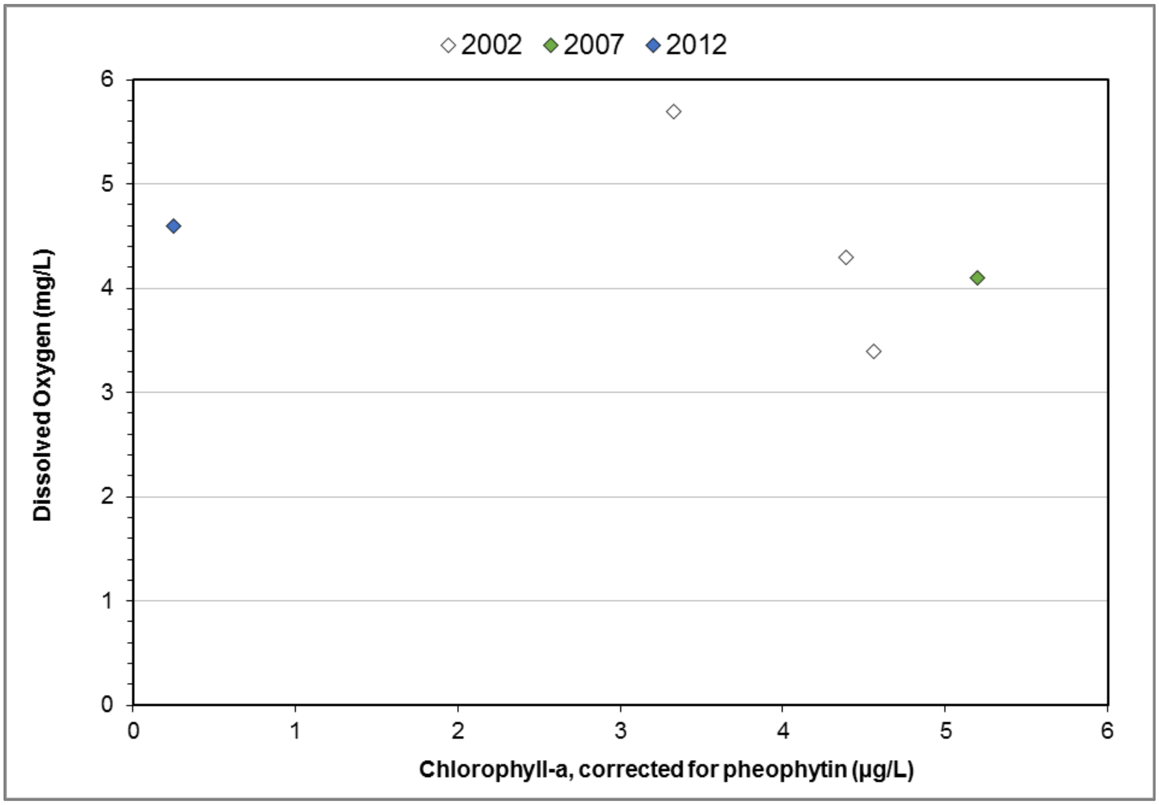

Figure 11. Chlorophyll-*a* versus dissolved oxygen, 2002–2012, East Fork Silver Creek ODL-02.

4.3 Sugar Fork (ODLA-01)

Sugar Fork ODLA-01 is listed as impaired for aquatic life due to low dissolved oxygen. One Illinois EPA sampling site with relevant data was identified on Sugar Fork, ODLA-01. Continuous monitoring data were collected in 2017, with multiple violations of the standard (Figure 12). Two samples were collected at ODLA-01 in 2007 (Figure 13). One violation of the general use water quality standard was observed in July 2007. Aquatic life use impairment is verified on this segment.

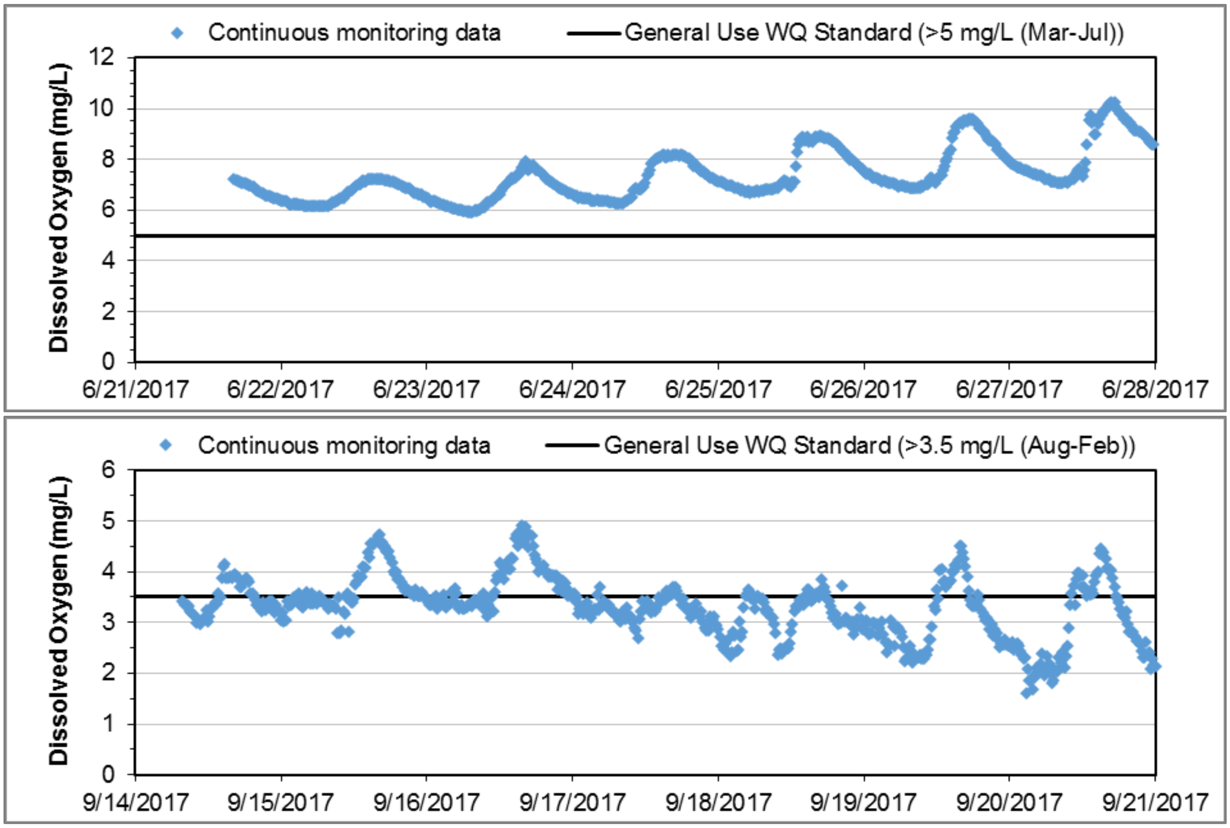

Figure 12. Continuous water quality time series for dissolved oxygen, Sugar Fork ODLA-01.

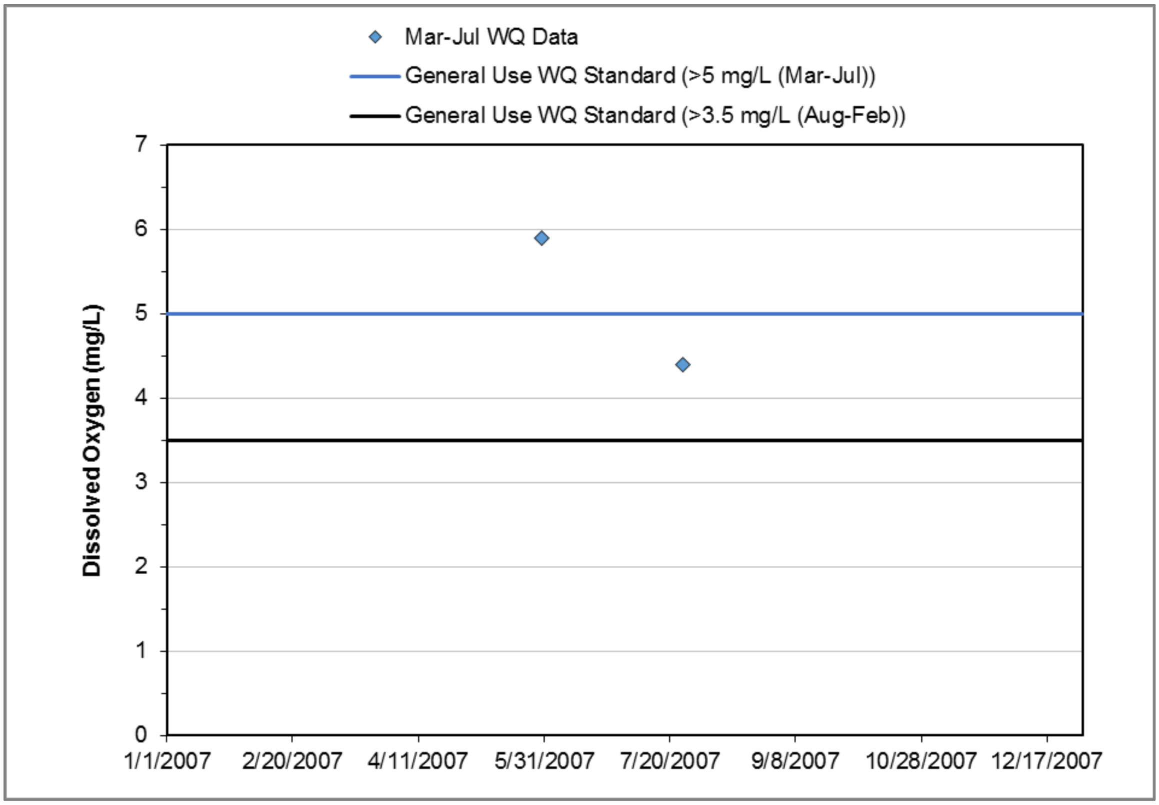

Figure 13. Dissolved oxygen water quality time series, Sugar Fork ODLA-01.

Further review of available data was conducted to determine the cause of impairment:

- **Point Sources:** There are no point sources contributing to the impaired segment.
- **Eutrophication:** Limited phosphorus and chlorophyll-*a* data were available to determine if eutrophication is contributing to low dissolved oxygen conditions. In two samples collected in 2007, an average total phosphorus concentration of 0.31 mg/L and an average chlorophyll-*a* concentration of 10.6 µg/L was observed. Additional data collection could include paired phosphorus and chlorophyll-*a* to determine if eutrophication is contributing to the ODLA-01 low dissolved oxygen impairment.
- **Physical Properties:** Based on review of aerial photos, Sugar Fork is highly ditched and channelized and surrounded by agricultural fields.

Sugar Fork ODLA-01 is also listed as impaired for aquatic life use due to high manganese. One IEPA sampling site was identified on the stream, ODLA-01. No samples during data collection in 2007 were recorded above the general use chronic standard for manganese (Figure 14). It is recommended that additional manganese data be collected to verify impairment.

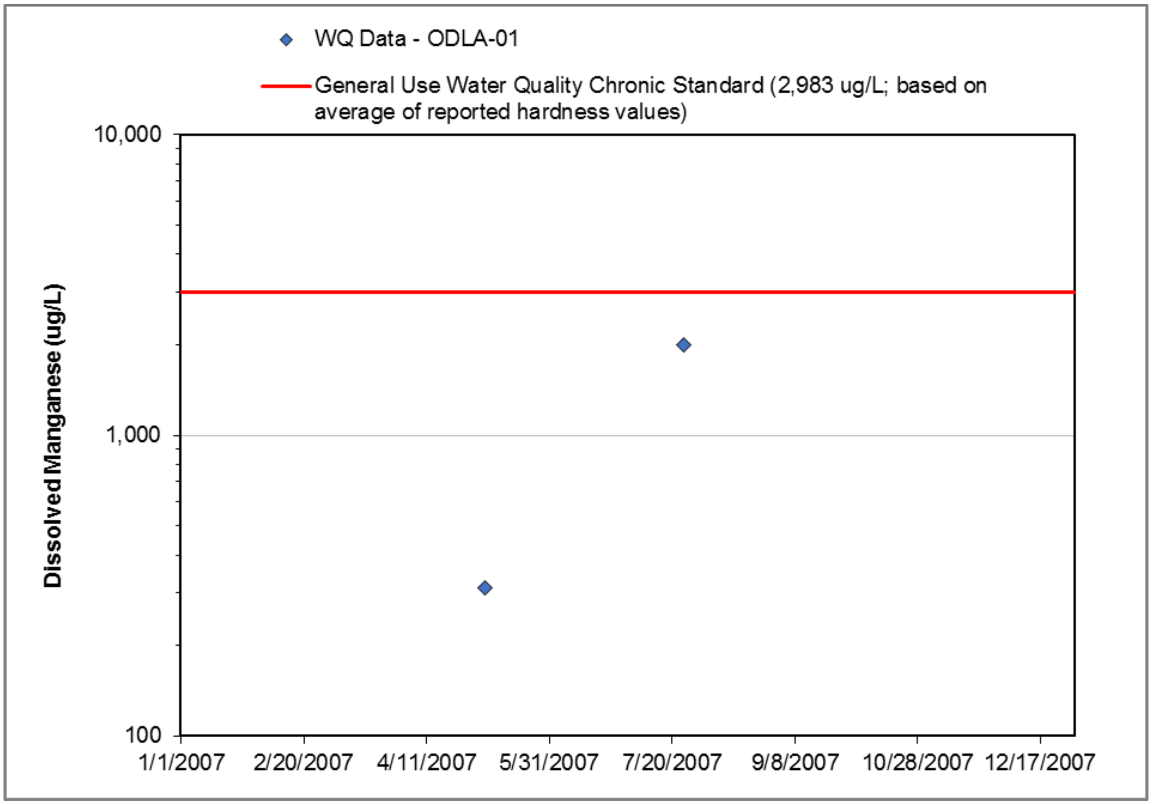

Figure 14. Manganese water quality time series, Sugar Fork ODLA-01.

4.4 Doza Creek (OZD)

Doza Creek OZD is listed as impaired for aquatic life due to low dissolved oxygen. Three Illinois EPA sampling sites with relevant data were identified on Doza Creek: OZD-01, OZD-MA-C1, and OZD-MA-C2. Four samples were collected at the sampling sites in 2007 (Table 13 and Figure 15). One violation of the general use water quality standard was observed at OZD-01 in July 2007. Continuous monitoring data were collected in 2017, with multiple violations of the standard (Figure 16). Aquatic life use impairment is verified on this segment.

Table 13. Data summary, Doza Creek OZD

Sample Site	No. of samples	Minimum (mg/L)	Average (mg/L)	Maximum (mg/L)	Number of exceedances of general use water quality standard (>5 mg/L (Mar-Jul) and >3.5 mg/L (Aug-Feb))
Dissolved Oxygen					
OZD-01	2	3.4	4.3	5.1	1
OZD-MA-C1	1	5.3	5.3	5.3	0
OZD-MA-C2	1	5.8	5.8	5.8	0

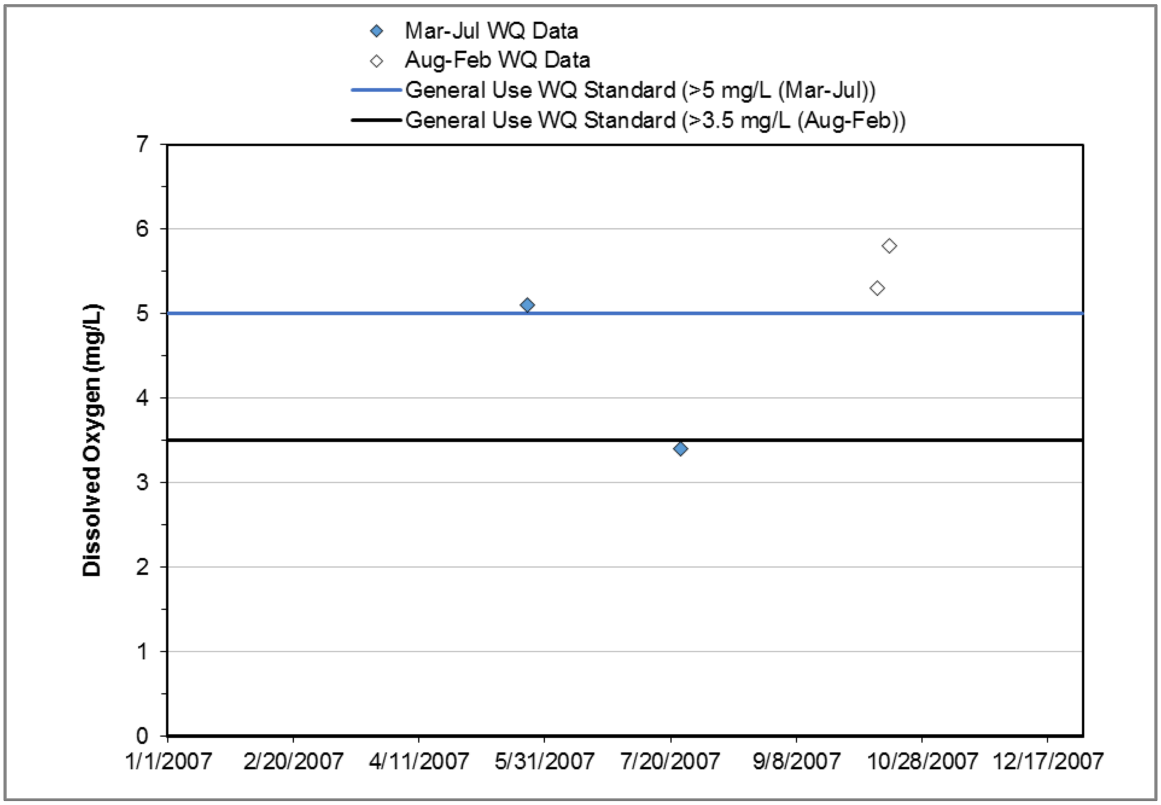

Figure 15. Dissolved oxygen water quality time series, Doza Creek OZD.

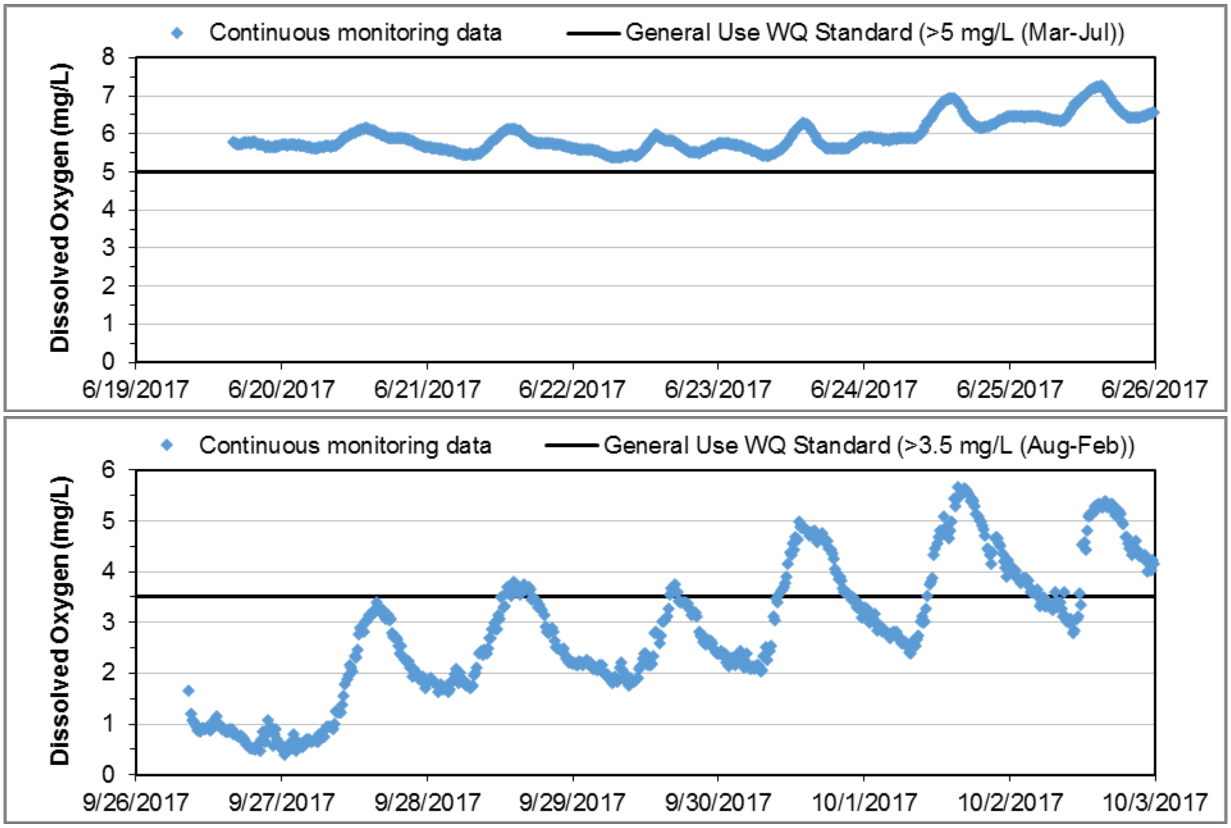

Figure 16. Continuous water quality time series for dissolved oxygen, Doza Creek OZD (site OZD-01)

Further review of available data was conducted to determine the cause of impairment:

- **Point Sources:** There are several point sources that, according to their permits, discharge to Doza Creek: Dynegy Midwest Generation–Baldwin (IL0000043) coal pile runoff and Hillside Recreational Lands, LLC–Randolph Preparation Plant (IL0062740) acid and alkaline mine drainage and stormwater. Additionally, Marissa STP (IL0024813) discharges to an unnamed tributary of Doza Creek approximately 0.65 miles upstream of Doza Creek. Monitoring data from October 2007 show high phosphorus concentrations in the unnamed tributary and in Doza Creek just below the confluence with the tributary. Lenzburg STP (ILG580013) also discharges to an unnamed tributary of Doza Creek. Point sources may contribute to the OZD low dissolved oxygen impairment.

- **Eutrophication:** Available phosphorus and chlorophyll-*a* data were reviewed to determine if eutrophication contributes to low dissolved oxygen conditions. Phosphorus versus dissolved oxygen data collected from 2007 do not indicate a strong correlation (Figure 17). Chlorophyll-*a* values are low with an average concentration from two samples of 4.7 µg/L, which does not indicate eutrophic conditions. Additional data collection should include paired phosphorus and chlorophyll-*a* to further investigate if eutrophication contributes to the OZD low dissolved oxygen impairment.

- **Physical Properties:** Based on review of aerial photos, Doza Creek is highly ditched and channelized and surrounded by agricultural practices.

Although the impairment has been verified, a strong link to a pollutant is not present. Additional data could be collected to further evaluate the cause and extent of impairment.

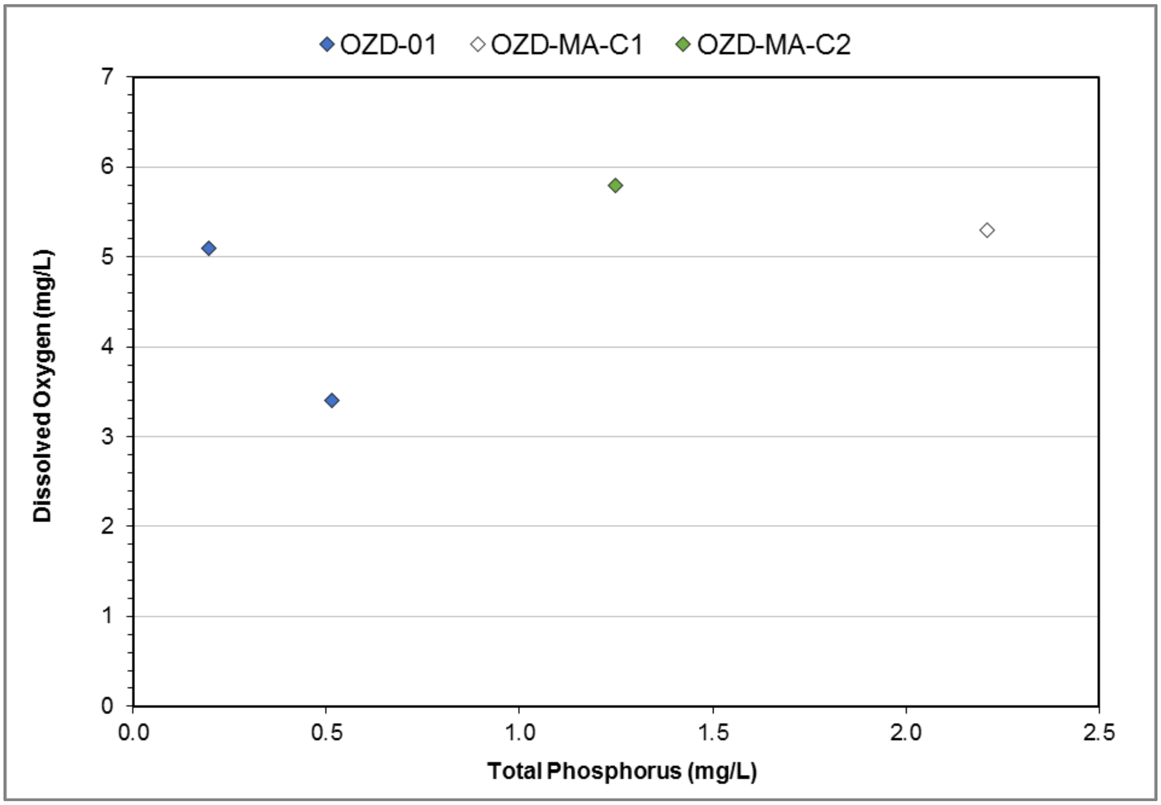

Figure 17. Total phosphorus versus dissolved oxygen, 2007, Doza Creek OZD.

Doza Creek OZD is also listed as impaired for aquatic life use due to high manganese. One IEPA sampling site was identified on the stream, OZD-01. No samples during data collection in 2007 were recorded above the general use chronic standard for manganese (Figure 18). It is recommended that additional manganese data be collected to verify impairment.

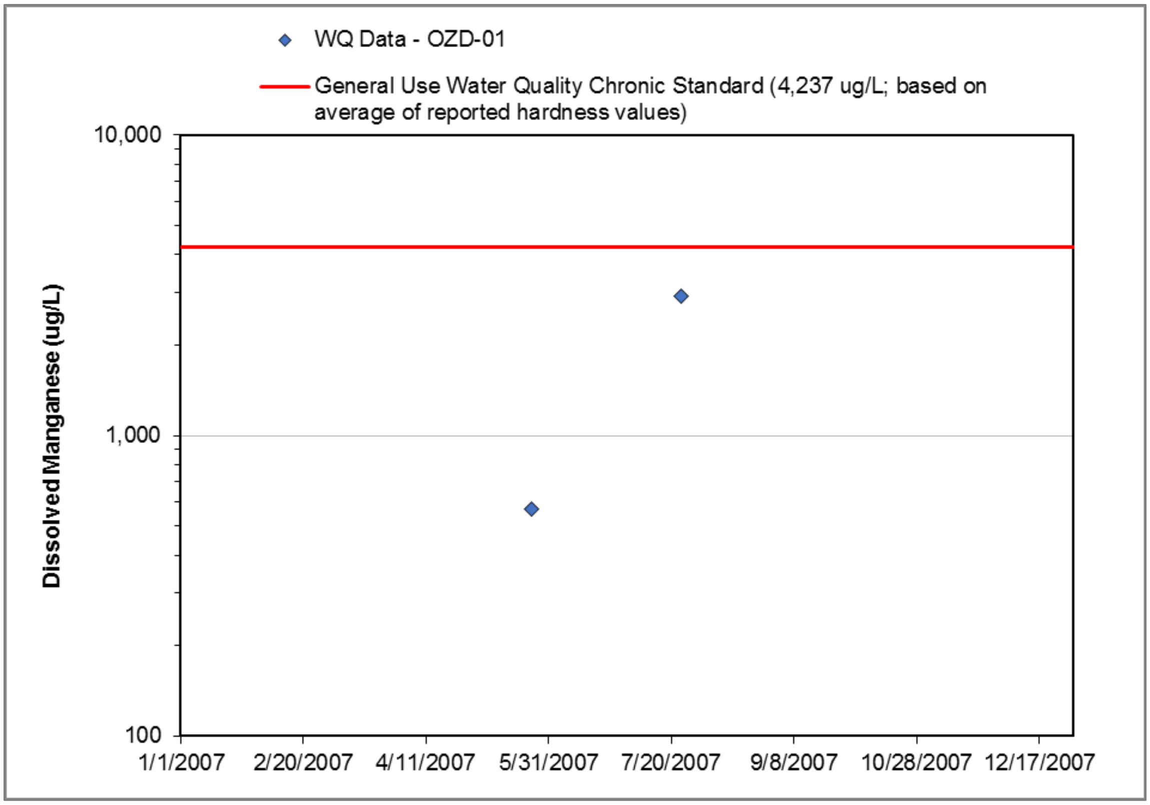

Figure 18. Manganese water quality time series, Doza Creek OZD-01.

5. TMDL Methods and Data Needs

The first stage of this project is an assessment of available data, followed by evaluation of their credibility. The types of data available, their quantity and quality, and their spatial and temporal coverage relative to impaired segments or watersheds drive the approaches used for TMDL model selection and analysis. Credible data are those that meet specified levels of data quality, with acceptance criteria defined by measurement quality objectives, specifically their precision, accuracy, bias, representativeness, completeness, and reliability. The following sections describe the methods that are proposed to derive TMDLs and the additional data needed to develop credible TMDLs.

TMDLs are proposed for segments with verified impairments and known pollutants (Table 14). A duration curve approach is suggested to evaluate the relationships between hydrology and water quality and to calculate the TMDLs for iron impairments.

The Qual2K model is proposed to evaluate the confirmed low dissolved oxygen impairments where point sources are present. If point sources are not present and if there is a correlation with eutrophication (i.e., phosphorus concentration or high levels of algae and/or plant growth), a duration curve approach is suggested to develop a phosphorus TMDL. The phosphorus target will be derived from the relationship between phosphorus and dissolved oxygen in the impaired stream. TMDLs are not proposed for dissolved oxygen impairments that are not affected by point sources and do not show a correlation with eutrophication. In these cases, it is assumed that the cause of impairment is non-pollutant based (e.g., the effect of lack of re-aeration in low-gradient streams or the effect of hydromodification).

Table 14. Proposed Model Summary

Name	Segment ID	Designated Uses	TMDL Parameter(s)	Proposed Model	Proposed Pollutant
Kaskaskia River	IL_O-03	Aquatic Life	Dissolved Oxygen	Qual2K	Biochemical oxygen demand, ammonia, total phosphorus
	IL_O-20	Public and Food Processing Water Supply	Iron	Load duration curve	Iron
	IL_O-30	Aquatic Life	Iron	Load duration curve	Iron
East Fork Silver Creek	IL_ODL-02	Aquatic Life	Dissolved Oxygen	Qual2K	Biochemical oxygen demand, ammonia, total phosphorus
Sugar Fork	IL_ODLA-01	Aquatic Life	Dissolved Oxygen	Load duration curve or 4C classification	Phosphorus or non-pollutant
			Manganese	Load duration curve, pending impairment verification	Manganese
Doza Creek	IL_OZD	Aquatic Life	Dissolved Oxygen	Qual2K	Biochemical oxygen demand, ammonia, total phosphorus
			Manganese	Load duration curve, pending impairment verification	Manganese

5.1.1 Load Duration Curve Approach

The primary benefit of duration curves in TMDL development is to provide insight regarding patterns associated with hydrology and water quality concerns. The duration curve approach is particularly applicable because water quality is often a function of stream flow. For instance, sediment concentrations typically increase with rising flows as a result of factors such as channel scour from higher velocities. Other parameters, such as chloride, may be more concentrated at low flows and more diluted by increased water volumes at higher flows. The use of duration curves in water quality assessment creates a framework that enables data to be characterized by flow conditions. The method provides a visual display of the relationship between stream flow and water quality.

Allowable pollutant loads have been determined through the use of load duration curves. Discussions of load duration curves are presented in *An Approach for Using Load Duration Curves in the Development of TMDLs* (U.S. EPA 2007). This approach involves calculating the allowable loadings over the range of flow conditions expected to occur in the impaired stream by taking the following steps:

1. A flow duration curve for the stream is developed by generating a flow frequency table and plotting the data points to form a curve. The data reflect a range of natural occurrences from extremely high flows to extremely low flows.

2. The flow curve is translated into a load duration (or TMDL) curve by multiplying each flow value (in cubic feet per second) by the water quality standard/target for a contaminant (mg/L), then multiplying by conversion factors to yield results in the proper unit (i.e., pounds per day). The resulting points are plotted to create a load duration curve.

3. Each water quality sample is converted to a load by multiplying the water quality sample concentration by the average daily flow on the day the sample was collected. Then, the individual loads are plotted as points on the TMDL graph and can be compared to the water quality standard/target, or load duration curve.

4. Points plotting above the curve represent deviations from the water quality standard/target and the daily allowable load. Those plotting below the curve represent compliance with standards and the daily allowable load. Further, it can be determined which locations contribute loads above or below the water quality standard/target.

5. The area beneath the TMDL curve is interpreted as the loading capacity of the stream. The difference between this area and the area representing the current loading conditions is the load that must be reduced to meet water quality standards/targets.

6. The final step is to determine where reductions need to occur. Those exceedances at the right side of the graph occur during low flow conditions, and may be derived from sources such as illicit sewer connections. Exceedances on the left side of the graph occur during higher flow events, and may be derived from sources such as runoff. Using the load duration curve approach allows Illinois EPA to determine which implementation practices are most effective for reducing loads on the basis of flow regime.

Water quality duration curves are created using the same steps as those used for load duration curves except that concentrations, rather than loads, are plotted on the vertical axis. Flows are categorized into the following five hydrologic zones (U.S. EPA 2007):

- High flow zone: stream flows that plot in the 0 to 10-percentile range, related to flood flows
- Moist zone: flows in the 10 to 40-percentile range, related to wet weather conditions
- Mid-range zone: flows in the 40 to 60-percentile range, median stream flow conditions
- Dry zone: flows in the 60 to 90-percentile range, related to dry weather flows
- Low flow zone: flows in the 90 to 100-percentile range, related to drought conditions

The duration curve approach helps to identify the issues surrounding the impairment and to roughly differentiate among sources. Table 15 summarizes the general relationship among the five hydrologic zones and potentially contributing source areas (the table is not specific to an individual pollutant). For example, the table indicates that impacts from point sources are usually most pronounced during dry and low flow zones because there is less water in the stream to dilute their loads. In contrast, impacts from stormwater are most pronounced during moist and high flow zones due to increased overland flow from stormwater source areas during rainfall events.

Table 15. Relationship between duration curve zones and contributing sources

Contributing source area	Duration Curve Zone				
	High	Moist	Mid-range	Dry	Low
Point source				M	H
Livestock direct access to streams				M	H
On-site wastewater systems	M	M-H	H	H	H
Stormwater: Impervious		H	H	H	
Stormwater: Upland	H	H	M		
Field drainage: Natural condition	H	M			
Field drainage: Tile system	H	H	M-H	L-M	

Note: Potential relative importance of source area to contribute loads under given hydrologic condition (H: High; M: Medium; L: Low).

The load reduction approach also considers critical conditions and seasonal variation in the TMDL development as required by the Clean Water Act and U.S. EPA's implementing regulations. Because the approach establishes loads on the basis of a representative flow regime, it inherently considers seasonal variations and critical conditions attributed to flow conditions. An underlying premise of the duration curve approach is correlation of water quality impairments to flow conditions. The duration curve alone does not consider specific fate and transport mechanisms, which may vary depending on watershed or pollutant characteristics.

5.1.2 Qual2K

Qual2K is a steady-state water quality model that simulates eutrophication kinetics and conventional water quality parameters and is maintained by U.S. EPA. Qual2K simulates up to 15 water quality constituents in branching stream systems. A stream reach is divided into a number of computational elements, and for each computational element, a hydrologic balance in terms of stream flow (e.g., m^3/s), a heat balance in terms of temperature (e.g., degrees C), and a material balance in terms of concentration (e.g., mg/l) are written. Both advective and dispersive transport processes are considered in the material balance. Mass is gained or lost from the computational element by transport processes, wastewater discharges, and withdrawals. Mass can also be gained or lost by internal processes such as release of mass from benthic sources or biological transformations.

The program simulates changes in flow conditions along the stream by computing a series of steady-state water surface profiles. The calculated stream-flow rate, velocity, cross-sectional area, and water depth serve as a basis for determining the heat and mass fluxes into and out of each computational element due to flow. Mass balance determines the concentrations of constituents at each computational element. In addition to material fluxes, major processes included in the mass balance are transformation of nutrients, algal production, benthic and carbonaceous demand, atmospheric reaeration, and the effect of these processes on the dissolved oxygen balance. The nitrogen cycle is divided into four compartments: organic nitrogen, ammonia nitrogen, nitrite nitrogen, and nitrate nitrogen. The primary internal sink of dissolved oxygen in the model is biochemical oxygen demand (BOD). The major sources of dissolved oxygen are algal photosynthesis and atmospheric reaeration.

The model is applicable to dendritic streams that are well mixed. It assumes that the major transport mechanisms, advection and dispersion, are significant only along the main direction of flow (the longitudinal axis of the stream or canal). It allows for multiple waste discharges, withdrawals, tributary flows, and incremental inflow and outflow.

Hydraulically, Qual2K is limited to the simulation of time periods during which both the stream flow in river basins and input waste loads are essentially constant. Qual2K can operate as either a steady-state or a quasi-dynamic model, making it a very helpful water quality planning tool. When operated as a steady-state model, it can be used to study the impact of waste loads (magnitude, quality, and location) on instream water quality. By operating the model dynamically, the user can study the effects of diurnal variations in meteorological data on water quality (primarily dissolved oxygen and temperature) and also can study diurnal dissolved oxygen variations due to algal growth and respiration. However, the effects of dynamic forcing functions, such as headwater flows or point loads, cannot be modeled in Qual2K. A steady-state model is proposed for all segments.

Qual2K is an appropriate choice for certain types of dissolved oxygen and organic enrichment TMDLs that can be implemented at a moderate level of effort. Use of the Qual2K models in TMDLs is most appropriate when (1) full vertical mixing can be assumed, and (2) water quality excursions are associated with identifiable critical flow conditions. Because these models do not simulate dynamically varying flows, their use is limited to evaluating responses to one or more specific flow conditions. The selected flow condition should reflect critical conditions, which for dissolved oxygen occurs when flows are low and the ambient air temperature is warm, typically in July or August.

5.2 Additional Data Needs

Data satisfy two key objectives for Illinois EPA, enabling the agency to make informed decisions about the resource. These objectives include developing information necessary to:

- Determine if the impaired areas are meeting applicable water quality standards for their respective designated use(s)
- Support modeling and assessment activities required to allocate pollutant loadings for all impaired areas where water quality standards are not being met

Additional data may be needed to understand probable sources, calculate reductions, develop calibrated water quality models, and develop effective implementation plans. Table 16 summarizes the additional data needed for each impaired segment.

Table 16. Additional data needs

<table>
<tr><th>Name</th><th>Segment ID</th><th>Designated Uses</th><th>TMDL Parameters</th><th>Additional Data Needs</th></tr>
<tr><td rowspan="3">Kaskaskia River</td><td>IL_O-03</td><td>Aquatic Life</td><td>Dissolved Oxygen</td><td>Yes, to support Qual2K model</td></tr>
<tr><td>IL_O-20</td><td>Public and Food Processing Water Supply</td><td>Iron</td><td>None</td></tr>
<tr><td>IL_O-30</td><td>Aquatic Life</td><td>Iron</td><td>None</td></tr>
<tr><td>East Fork Silver Creek</td><td>IL_ODL-02</td><td>Aquatic Life</td><td>Dissolved Oxygen</td><td>Yes, to support Qual2K model</td></tr>
<tr><td rowspan="2">Sugar Fork</td><td rowspan="2">IL_ODLA-01</td><td rowspan="2">Aquatic Life</td><td>Dissolved Oxygen</td><td>Yes, to determine relationship with eutrophication</td></tr>
<tr><td>Manganese</td><td>Yes, to verify impairment</td></tr>
<tr><td rowspan="2">Doza Creek</td><td rowspan="2">IL_OZD</td><td rowspan="2">Aquatic Life</td><td>Dissolved Oxygen</td><td>Yes, to support Qual2K model</td></tr>
<tr><td>Manganese</td><td>Yes, to verify impairment</td></tr>
<tr><td>All</td><td>All</td><td>All</td><td>All</td><td>Implementation plan development</td></tr>
</table>

Specific data needs include:

Support Qual2K Model Development on Kaskaskia River O-03—Due to the size of the river and its drainage area, a total of five monitoring stations are needed. Ideally, there would be two separate data collection periods, each time period lasting roughly one week during critical conditions (low flow, warm conditions). Although the five monitoring stations are a minimum, adding more locations along the reach of interest will help determine how heterogeneous the system is and what dynamics are occurring along the reach. Monitoring stations can be located downstream of key tributaries, at road crossings, etc. as deemed necessary.

Recommended monitoring includes:

- Sites O-91, O-03 (work with USGS to collect additional samples needed at O-03/USGS 05595000), and O-55:
  - Continuous dissolved oxygen, stream temperature, conductivity, and pH monitoring during a warm, low flow period in July; monitoring should take place over approximately two weeks.
  - Multiple samples of organic nitrogen, ammonia nitrogen, nitrate nitrogen, TKN, organic phosphorus, soluble reactive phosphorus, total inorganic carbon, total organic carbon, carbonaceous biochemical oxygen demand (5-day and 20-day if possible), chemical oxygen demand (COD), inorganic solids, chlorophyll-*a*, and alkalinity. Depending on the monitoring station, grab samples could be collected twice per day during the first and last days of sonde deployment or throughout the week.
  - Macrophyte and attached algae survey, survey of groundwater and tributary contributions (in addition to Mud Creek and Silver Creek listed below), if any.
  - Survey of channel substrate and bottom material.
- Sites on Mud Creek (OE-02) and Silver Creek (OD-04):
  - Continuous dissolved oxygen, stream temperature, conductivity, and pH monitoring during the same period as data collected on the main stem sites.
  - Multiple samples of organic nitrogen, ammonia nitrogen, nitrate nitrogen, TKN, organic phosphorus, soluble reactive phosphorus, total inorganic carbon, total organic carbon, carbonaceous biochemical oxygen demand (5-day and 20-day if possible), chemical oxygen demand (COD), inorganic solids, chlorophyll-*a*, and alkalinity. Depending on the monitoring station, grab samples could be collected twice per day during the first and last days of sonde deployment or throughout the week.
- A longitudinal/synoptic survey of DO concentrations along the entire reach.
- Funding permitted: *in-situ* measurements of stream reaeration (via diffusion dome technique) and in-situ measurements of sediment oxygen demand (via chambers deployed on the streambed). Sediment bed surveys can be conducted potentially in lieu of sediment oxygen demand (SOD) sampling (sediment total organic carbon sampling for instance could be a rough proxy for SOD if needed).
- Photo documentation of the system.

Support Qual2K Model Development on East Fork Silver Creek ODL-02—Although there are continuous DO data from 2017, there are no known water quality data from the same time period. A minimum of two monitoring stations are needed on the impaired segment, in addition to a station on Sugar Branch near the confluence with East Fork Silver Creek. Ideally, there would be two separate data collection periods, each time period lasting roughly one week during critical conditions (low flow, warm conditions). Although two monitoring locations on the impaired segment are a minimum, adding more locations along the reach of interest will help determine how heterogeneous the system is and what dynamics are occurring along the reach. Monitoring stations can be located downstream of key tributaries, at road crossings, etc. as deemed necessary.

Recommended monitoring includes:

- Station ODL-02, new monitoring station on IL ODLA-01 located at County Road 600 N road crossing, and at the Highland Silver Lake dam:
  - Continuous dissolved oxygen, stream temperature, conductivity, and pH monitoring during a warm, low flow period in July; monitoring should take place over approximately two weeks.
  - Flow monitoring (depth and velocity) during dissolved oxygen monitoring at least twice; the number of measurements will be dependent on weather and stream conditions.
  - Multiple samples of organic nitrogen, ammonia nitrogen, nitrate nitrogen, TKN, organic phosphorus, soluble reactive phosphorus, total inorganic carbon, total organic carbon, carbonaceous biochemical oxygen demand (5-day and 20-day if possible), inorganic solids, chlorophyll-*a*, and alkalinity. Depending on the monitoring station, grab samples could be collected twice per day during the first and last days of sonde deployment or throughout the week.
  - Macrophyte and attached algae survey, survey of groundwater and tributary contributions, if any.
  - Channel geometry, shade/vegetative survey, cloud cover, and channel substrate and bottom material, both upstream and downstream of the monitoring stations(s).
- A longitudinal/synoptic survey of DO concentrations along the entire reach (hand-sampling by probe on foot or from a row-boat periodically along the entire reach extent).
- Funding permitted: *in-situ* measurements of stream reaeration (via diffusion dome technique) and in-situ measurements of sediment oxygen demand (via chambers deployed on the streambed). Sediment bed surveys can be conducted potentially in lieu of sediment oxygen demand (SOD) sampling (sediment total organic carbon sampling for instance could be a rough proxy for SOD if needed).
- Photo documentation of the system.

Confirm Impairment and Determine Relationship with Eutrophication on IL_ODLA-01—Collect DO, chlorophyll-*a*, and TP grab samples at station ODLA-01; two samples per day (one per day in the early morning) on three separate sampling days, during the warm summer months (July–August) and during low flows.

Verify Manganese Impairment on Sugar Fork IL_ODLA-01—Three samples should be analyzed for manganese and for hardness at station ODLA-01.

Support Qual2K Model Development on Doza Creek OZD—A minimum of two monitoring stations are needed on the impaired segment, in addition to a station on each of the major tributaries (one station on the tributary that enters from the south where it intersects with Waeltz Road; another station on the tributary that enters from the north where it intersects with Schmoll Road), for a total of four sites. Ideally, there would be two separate data collection periods, each time period lasting roughly one week during critical conditions (low flow, warm conditions). Adding more locations along the reach of interest would help determine how heterogeneous the system is and what dynamics are occurring along the reach. Monitoring stations can be located downstream of key tributaries, at road crossings, etc. as deemed necessary.

Recommended monitoring includes:

- Station OZD-MA-C1, OZD-01:
  - Continuous dissolved oxygen, stream temperature, conductivity, and pH monitoring during a warm, low flow period in July; monitoring should take place over approximately two weeks at a minimum of two locations.
  - Flow monitoring (depth and velocity) during dissolved oxygen monitoring at least twice at two locations, the number of measurements will be dependent on weather and stream conditions.
  - Multiple samples of organic nitrogen, ammonia nitrogen, nitrate nitrogen, TKN, organic phosphorus, soluble reactive phosphorus, total inorganic carbon, total organic carbon, carbonaceous biochemical oxygen demand (5-day and 20-day if possible), chemical oxygen demand (COD), inorganic solids, chlorophyll-*a*, alkalinity, dissolved iron, and total iron. Depending on the monitoring station, grab samples could be collected twice per day during the first and last days of sonde deployment or throughout the week.
  - Macrophyte and attached algae survey, survey of groundwater and tributary contributions, if any.
  - Channel geometry, shade/vegetative survey, cloud cover, observations of iron precipitates, channel substrate and bottom material, both upstream and downstream of the monitoring stations(s).
- Tributaries—one station on the tributary that enters from the south where it intersects with Waeltz Road; another station on the tributary that enters from the north where it intersects with Schmoll Road:
  - Continuous dissolved oxygen, stream temperature, conductivity, and pH monitoring during the same period as data collected on the main stem sites.
  - Multiple samples of organic nitrogen, ammonia nitrogen, nitrate nitrogen, TKN, organic phosphorus, soluble reactive phosphorus, total inorganic carbon, total organic carbon, carbonaceous biochemical oxygen demand (5-day and 20-day if possible), chemical oxygen demand (COD), inorganic solids, chlorophyll-*a*, alkalinity, dissolved iron, and total iron. Depending on the monitoring station, grab samples could be collected twice per day during the first and last days of sonde deployment or throughout the week.
- A longitudinal/synoptic survey of DO concentrations along the entire reach.
- Funding permitted: *in-situ* measurements of stream reaeration (via diffusion dome technique) and in-situ measurements of sediment oxygen demand (via chambers deployed on the streambed). Sediment bed surveys can be conducted potentially in lieu of sediment oxygen demand (SOD) sampling (sediment total organic carbon sampling for instance could be a rough proxy for SOD if needed).
- Photo documentation of the system.

Verify Manganese Impairment on Doza Creek OZD—Three samples should be analyzed for manganese and for hardness at station OZD-01.

Implementation Plan Development—Further in-field assessment may be needed to better determine the source of impairments in order to develop an effective TMDL implementation plan. Additional monitoring could include:

- Windshield surveys
- Streambank surveys and stream assessments
- Lakeshore assessment
- Farmer/landowner surveys
- Word of mouth and in-person conversations with local stakeholders and landowners

6. Public Participation

<to be updated based on Stage 1 meetings>

7. References

Horsley and Witten, Inc. 1996. Identification and Evaluation of Nutrient and Bacterial Loadings to Maquoit Bay, Brunswick, and Freeport, Maine. Casco Bay Estuary Project.

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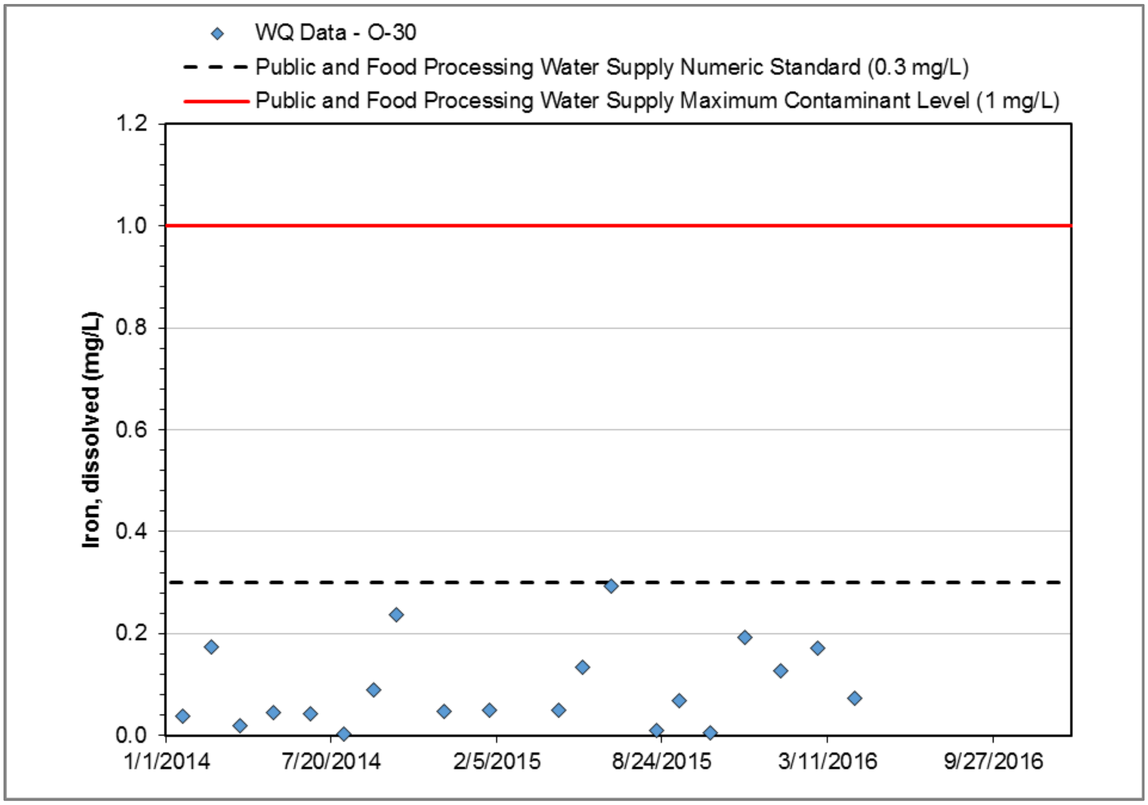
Appendix A—Unimpaired Stream Data Analysis

Kaskaskia River (O-30)

Kaskaskia River O-30 is listed for not supporting Public and Food Processing Water Supplies due to elevated levels of iron (dissolved). One IEPA sampling site was identified on the segment, O-30. No samples over the last three years of data collection (2014–2016) were recorded above the 0.3 mg/L drinking water protection numeric standard or 1 mg/L MCL. It is therefore recommended that the segment be delisted for Public and Food Processing Water Supplies use.

Iron data summary, Kaskaskia River O-30

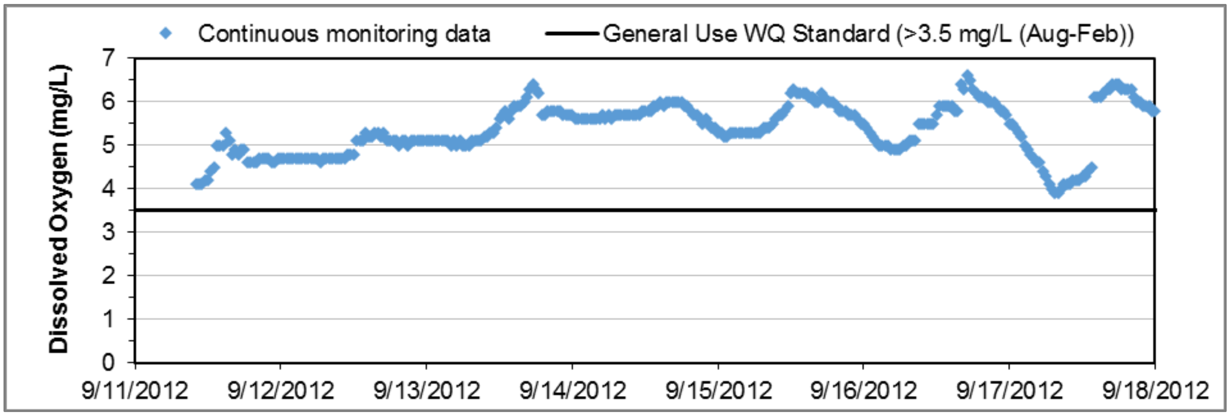
Sample Site	Date	Result (mg/L)	Quarterly Average (mg/L)
Iron, dissolved			
O-30	1/22/2014	0.04	0.11
	2/26/2014	0.17	
	4/1/2014	0.02	0.04
	5/12/2014	0.04	
	6/25/2014	0.04	
	8/5/2014	0.00	0.05
	9/9/2014	0.09	
	10/7/2014	0.24	0.14
	12/3/2014	0.05	
	1/27/2015	0.05	0.049
	4/21/2015	0.05	
	5/20/2015	0.13	0.16
	6/23/2015	0.29	
	8/17/2015	0.01	0.04
	9/14/2015	0.07	
	10/21/2015	0.01	0.10
	12/3/2015	0.19	
	1/14/2016	0.13	0.15
	2/29/2016	0.17	
	4/13/2016	0.07	0.07



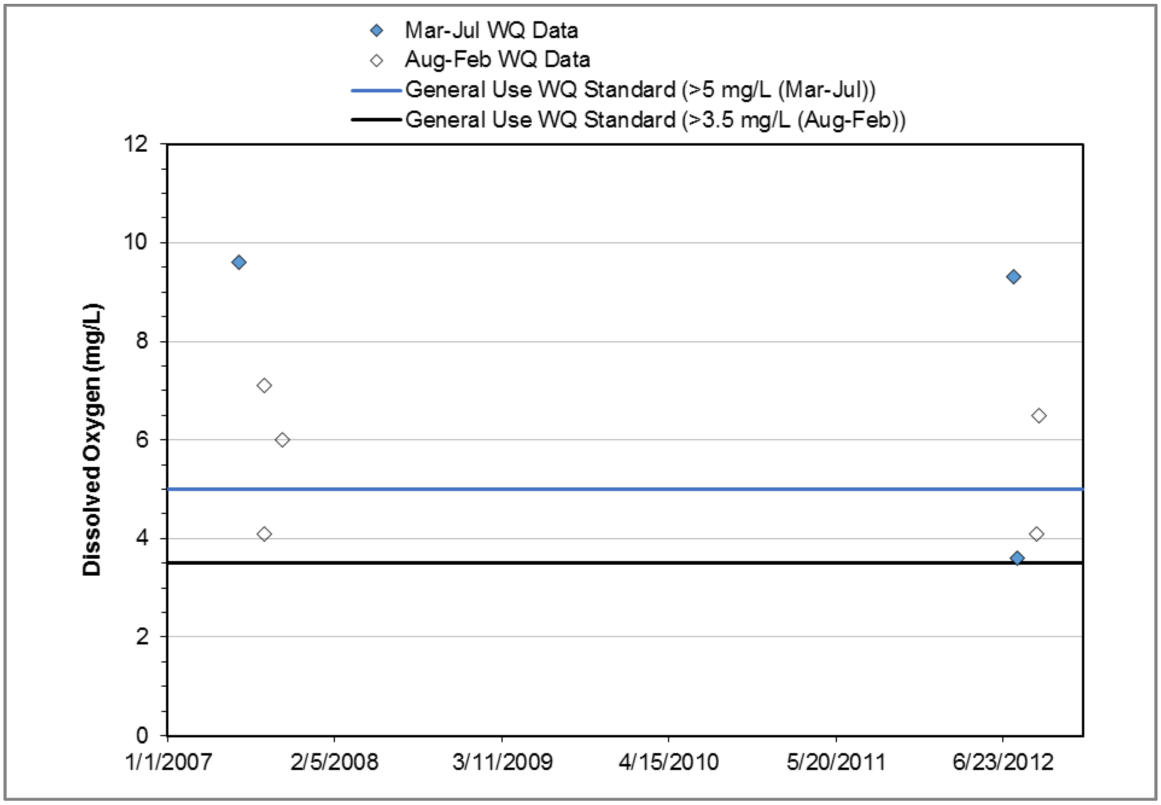
Iron water quality time series, Kaskaskia River O-30 segment.

Kaskaskia River (O-97)

Kaskaskia River O-97 is listed for not supporting aquatic life due to low dissolved oxygen. Continuous dissolved oxygen data were collected in July and September 2012, however the July data were determined to be unreliable. The dissolved oxygen standard was not violated during 7 days in September (see figure below). There were eight additional grab samples collected at O-04 between 2007 and 2012, with one that violated the standard (see figure below). A reach is considered impaired due to dissolved oxygen if greater than 10 percent of the samples violate the standard. In this case, less than 10 percent of the samples violated the standard and therefore it is recommended that the segment be delisted for aquatic life.



Continuous water quality time series for dissolved oxygen, Kaskaskia River O-97 segment.



Dissolved oxygen water quality time series, Kaskaskia River O-97 segment.